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CATALOGUE

OF THE

MICHIGAN MINING SCHOOL.

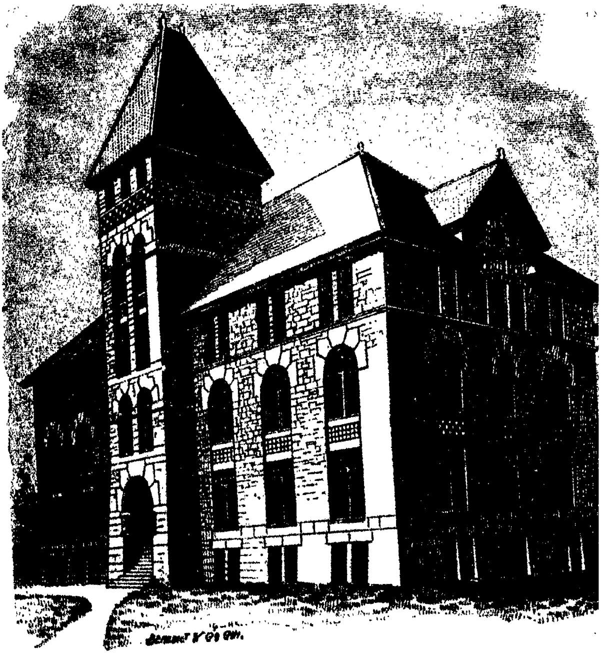
1892-1894.

ANNOUNCEMENTS.

1895-1896.

HOUGHTON, MICHIGAN.

HOUGHTON, MICHIGAN.
PUBLISHED BY THE MINING SCHOOL
1894.



CATALOGUE

OF THE

MICHIGAN MINING SCHOOL.

1892-1894.

WITH STATEMENTS CONCERNING THE INSTITUTION
AND ITS COURSES OF INSTRUCTION
FOR 1895-1896.

HOUGHTON, MICHIGAN.

HOUGHTON, MICH., U. S. A.
PUBLISHED BY THE MINING SCHOOL.
JULY, 1894.

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TO THE PUBLIC.

Although this Catalogue is for the years 1892–1894, its statements and calendar also apply to 1894–1895, and 1895–1896.

This Catalogue does not follow entirely the usual form of such a publication, but it has been prepared to answer each and every question that has been asked the Director concerning the institution for nearly seven years. Hence all persons seeking for information concerning this School are requested to look in the Table of Contents for the title under which their subject naturally falls, and then examine the statements made upon the pages referred to.

If the information can not be found, then application should be made in person or by letter to the Director, stating what points are not understood, or upon what subjects information is desired. Experience, however, has shown that for the past three years hardly any questions have been asked, that have not been more fully answered in the Catalogue than it is possible to do in a letter. The Director is the proper officer to apply to for catalogues, for all matters relating to the courses of study, admission qualifications, blank certificates, and in short, for anything relating to the educational side of the School; while all communications concerning purchases, bills and financial matters should be addressed to the Treasurer of the Mining School. All parties writing for catalogues or information, are particularly requested to see that their names and addresses are legibly and accurately given, for however familiar one may be with his own signature, the party to whom application is made for the Catalogue is not.

Very frequently catalogues and letters are returned to the School, owing to the parties asking for them having given an imperfect or incorrect address. In case of failure of any one to receive the Catalogue or information required, he should write again; as all requests of either kind that reach the Director are promptly attended to, and the information or Catalogue sent.

BOARD OF CONTROL OF THE MINING SCHOOL.

1892—1894.

	Term Expires.
Hon. John Monroe Longyear, Marquette	June 9, 1895.
Alfred Kidder, Marquette	June 9, 1895.
James Renrick Cooper, Hancock	June 9, 1897.
Preston Carpenter Firth West, Calumet	June 9, 1897.
Hon. Jay Abel Hubbell, Houghton	June 9, 1899.
Hon. Thomas Bree Dunstan, Hancock	June 9, 1899.

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SECRETARY OF THE BOARD OF CONTROL,
ALLEN FORSYTH REES.

DIRECTOR OF THE MINING SCHOOL,
MARSHMAN EDWARD WADSWORTH.

TREASURER AND PURCHASING AGENT OF THE MINING SCHOOL,
ALLEN FORSYTH REES.

BOARD OF VISITORS TO THE MINING SCHOOL.

September 5th, 1892, to September 4th, 1893.

PROF. MORTIMER ELWYN COOLEY, ANN ARBOR, *Chairman.*

EDWARD LEROY PARMENTER, VULCAN.

HUGH BROWN, LANSING.

OFFICERS OF THE MICHIGAN MINING SCHOOL AND OF THE STATE GEOLOGICAL SURVEY.

1892–1893.

MARSHMAN EDWARD WADSWORTH, A. B. (Bowdoin College),
A. M., Ph. D. (Harvard University).
DIRECTOR AND STATE GEOLOGIST,
Professor of Mineralogy, Petrography and Geology.

GEORGE AUGUSTUS KOENIG, M. E. (Polytechnikum, Karlsruhe),
A. M., Ph. D (University of Heidelberg).
Professor of Chemistry, and Chemist on the Geological Survey.

LUCIUS LEE HUBBARD, A. B. (Harvard University), LL. B.
(Boston University), A. M., Ph. D. (University of Bonn).
Assistant in Mineralogy, and on the Geological Survey.

ARTHUR EDWARD HAYNES, M. S., M. Ph. (Hillsdale College),
Professor of Mathematics and Physics

HORACE BUSHNELL PATTON, A. B. (Amherst College),
Ph. D. (University of Heidelberg),
Instructor in Mineralogy and Petrography, and Assistant on the Geological Survey.

ALFRED CHURCH LANE, A. M , Ph. D. (Harvard University),
Instructor in Petrography and Geology, and Assistant on the Geological Survey.

EDGAR KIDWELL, A. M. (Georgetown University),
M. E. (University of Pennsylvania),
Professor of Mechanical and Electrical Engineering.

FRED FRALEY SHARPLESS, S. B. (University of Michigan),
Professor of Metallurgy, and Chemist on the Geological Survey.

Fred Warner Denton, C.E. (Columbia College School of Mines),
Professor of Civil and Mining Engineering.

Walter John Baldwin, S. B. (University of Michigan),
Assistant in Surveying.

Al Arthur Abbott, S. B. (Michigan Agricultural College),
Assistant in Physics.

Carroll Livingston Hoyt, M. E. (Cornell University),
Instructor in Mechanical Engineering and Drawing.

Arthur Edmund Seaman,
Assistant in Mineralogy, and on the Geological Survey

Milo Smith Ketchum,
Assistant in Surveying

Robert Irwin Rees,
Librarian and Clerk

John Bone Watson,
Draughtsman for the Geological Survey

James Wilton Shields
Assistant in the Machine Shops

Henry Gibbs
Janitor and Supply Clerk

Patrick Robert Dillon,
Engineer and Assistant Janitor

Miss Kate Killian,
Stenographer and Typewriter for the Mining School

Miss Helen Mary Ryan,
Stenographer and Typewriter for the Geological Survey

John Brimacombe,
Janitor's Assistant.

OFFICERS OF THE MICHIGAN MINING SCHOOL.

1893—1894.

Marshman Edward Wadsworth, A. B. (Bowdoin College),
A. M., Ph. D. (Harvard University),
Director,
Professor of Mineralogy, Petrography and Geology.

George Augustus Koenig, M. E. (Polytechnikum, Karlsruhe)
A. M., Ph. D. (University of Heidelberg),
Professor of Chemistry.

Edgar Kidwell, A. M. (Georgetown University),
M. E. (University of Pennsylvania),
Professor of Mechanical and Electrical Engineering

*Fred Fraley Sharpless, S. B. (University of Michigan),
Professor of Metallurgy.

†Fred Warner Denton, C E. (Columbia College School
of Mines),
Professor of Civil and Mining Engineering

Fred Walter McNair, S. B. (University of Wisconsin),
Professor of Mathematics and Physics.

Arthur Edmund Seaman,
Instructor in Mineralogy and Geology.

Ai Arthur Abbott, S. B. (Michigan Agricultural College),
E. M. (Michigan Mining School),
Instructor in Mechanical Engineering, Drawing and Surveying.

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*Resigned, to take effect September 14th, 1894.
†Resigned, to take effect June 2nd, 1894.

MISS FRANCES HANNA,
Librarian and Secretary.

ROBERT IRWIN REES,
In charge of the preparation of the Library Catalogue.

JAMES WILTON SHIELDS,
Assistant in the Machine Shops.

HORACE TRAITON PURFIELD,
Assistant in the Machine Shops.

RUSSELL TEAL MASON,
Assistant in Physics.

CARLTON FRANKLIN MOORE,
Assistant in Chemistry.

CARL RAYMOND DAVIS,
in Surveying.

HENRY GIBBS,
Supply Clerk and Janitor of Science Hall.

PATRICK ROBERT DILLON,
Engineer and Janitor of Engineering Hall.

MISS KATE KILLIAN,
Stenographer and Typewriter.

JOHN BRIMACOMBE,
Janitor's Assistant.

APPOINTMENTS FOR 1894-1895.

CARLTON FRANKLIN MOORE,
Instructor in Mechanical Engineering and Drawing.

BURTON TYNDALL SEELEY,
Assistant in Chemistry.

CARL RAYMOND DAVIS,
Assistant in Physics.

LOUIS ALDRO WRIGHT,
Assistant in Mineralogy.

— ——
Assistant in Chemistry.

FACULTY OF THE MINING SCHOOL.

Marshman Edward Wadsworth, A. M., Ph. D., Director,
Professor of Mineralogy, Petrography and Geology.

George Augustus Koenig, M. E., A. M., Ph. D.,
Professor of Chemistry.

Edgar Kidwell, A. M., M. E.,
Professor of Mechanical and Electrical Engineering.

Fred Fraley Sharpless, S. B.,
Professor of Metallurgy.

Fred Warner Denton, C. E.,
Professor of Civil and Mining Engineering.

Fred Walter McNair, S. B.,
Professor of Mathematics and Physics, Secretary of the Faculty.

REGISTER OF STUDENTS

FOR THE SCHOOL YEAR 1892-1893.

GRADUATE STUDENTS.

Name.	Residence.	Room.
DRAKE, FRANK, S. B., (Michigan Mining School), Chemistry, Mechanical and Electrical Engineering, Mineralogy, Petrography and Geology.	*Portland, Oregon.*	Keweenaw Club.
HARRIS, HERBERT EUGENE, S. B. (University of Wisconsin.) Shop Practice.	*Waupun, Wis.*	Mr. Kroll's.
KAMPE, WESLEY EDWARD, A. B., S. B. (Hanover College). Chemistry.	*Madison, Ind.*	Butterfield House.
NICOL, WILLIAM, M. A., (Queen's University), Assaying and Ore Dressing.		
SILLIMAN, ARTHUR PARKS, B. L., (University of Wisconsin), Mathematics, Chemistry, Electrical Engineering and Geology.	*Hudson, Wis.*	Mrs. Burrows's.

CLASS OF 1893.

Name.	Residence.	Room.
Abbott, Ai Arthur, S. B. (Michigan Agricultural College),	*Holt.*	Mrs. C. Didier's.
Church, George Batchelor,	*Flint.*	Mrs. Alford's.
Cranson, Robert Edward,	*St. John's.*	Mr. Cranson's.
Fisher, James,	*Hancock.*	Mr. Fisher's, Hancock.
Gillies, Donald,	*Lake Linden.*	Mrs. Alford's.
Harrington, Frederick Luce,	*Port Huron.*	Mrs. E. M. Hoar's.
Honnold, William Lincoln,	*Camp Point, Ill.*	Keweenaw Club.
Kirk, Marcus Eugene,	*Cincinnati, Ohio.*	Mrs. Rice's.
McDonald, Erwin Huntington,	*Lyon Mountain, N. Y.*	Butterfield House.
McDonald, William Neal,	*Houghton.*	Mr. McDonald's.
Ropes, Leverett Smith,	*Ishpeming.*	Mrs. Douglas's.
Tower, Louis Lovell,	*Ionia.*	Mrs. Rice's.
Trengove, Samuel Reed,	*Lake Linden.*	Mrs. Brimacombe's.
Waters, Albert Latcha, S. B. (Michigan Agricultural College),	*Spring Lake.*	Keweenaw Club.

CLASS OF 1894.

Name	Residence.	Room.
BRULÉ, FREDERICK JOSEPH,	*Lake Linden.*	Miss Kelly's.
BURRALL, FREDERICK PECK,	*Battle Creek.*	Mr. Cameron's.
CAMERON, DONALD,	*St. Louis.*	Mr. Davey's.
CORRIGAN, JOHN ALEXANDER,	*Cleveland, Ohio.*	Dallmeyer Block.
DURFEE, ELMER WHIPPLE,	*Grand Rapids.*	Mr. Hummel's.
EBY, JOHN HENRY, B. A., (Franklin and Marshall College),	*Lancaster, Pa.*	Mr. Hummel's.
JONES, MAURICE LINDLEY,	*Benton Harbor.*	Mrs. E. M. Hoar's.
KIRCHEN, JOHN GEORGE,	*Lake Linden.*	Dallmeyer Block.
KNIGHT, JOHN ALEXANDER,	*Ionia.*	Miss Jones's, Hancock.
MASON, CLARENCE GEORGE,	*Hancock.*	Mr. Mason's.
MASON, RUSSELL TEEL,	*Boulder, Colo.*	Mrs. C. Didier's.
MCCAULEY, JAMES,	*Hancock.*	Mr. McCauley's, Hancock.
MCCORMICK, EDWARD PATRICK,	*Calumet.*	Mrs. Burrows's.
MCFARLANE, GEORGE CAMPBELL,	*Bay City.*	Mrs. Beard's.
MCGRATH, MICHAEL,	*Hancock.*	Mr. McGrath's, Hancock.
MOORE, CARLTON FRANKLIN,	*Marquette.*	Mr. Sparling's.
NEWTON, LEE LUKE,	*Lake Linden.*	Miss Kelly's.
PARKS, HENRY JAMES,	*Lake Linden.*	Dallmeyer Block.

Name.	Residence.	Room.
Peiffer, Philip,	*Lake Linden.*	Mrs. C. Didier's.
Ridley, Frederick William,	*Newcastle-on-Tyne, England.*	Mrs. E. M. Hoar's.
Riedinger, Louis Edward,	*Marquette.*	Mrs. Rice's.
Rourke, Jerry,	*Hancock.*	Mr. Rourke's, Hancock.
Seeley, Burton Tyndall,	*Genessee Township.*	Mr. Sparling's.
Stringham, Joseph, Jr.,	*Saginaw.*	Mr. Stringham's.
Williams, Bert Henry,	*Champion.*	Mr. Ormsby's, Hancock.
Wraith, William,	*Newcastle, Colo.*	Mrs. Dallmeyer.

CLASS OF 1895.

Name.	Residence.	Room.
BARLOW, ROYCE ELWIN,	*Hastings.*	Mrs. Trim's.
BARSTOW, GEORGE MITCHELL,	*Detroit.*	Mrs. Beard's.
BATES, ARMAND WALTER,	*Ironwood.*	Mrs. Dallmeyer's.
BEARD, WILLIAM HENRY, Jr.,	*Stafford, Eng.*	Mr. Livermore's.
BEEN, JOHN THEODORE,	*Skanee.*	Mr. Lang's.
CALHOUN, CHARLES ANDREW,	*Albert Mines,* *Albert Co., N.B.*	Mrs. Mitchell's.
CAMERON, WILLIAM,	*St. Louis.*	Mr. Davey's.
CHANDLER, MARION INEZ,	*Hancock.*	Mr. Chandler's, Hancock.
CLARK, GEORGE CLOUGH,	*Springfield, Mo.*	Mrs. Brimacombe's.
COLEMAN, MILTON WATSON,	*Calumet.*	Hartman Block.
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CROZE, LAWRENCE LUDGER,	*Houghton.*	Mr. Croze's.
DAVIS, CARL RAYMOND,	*Helena, Mont.*	Mr. Lange's.
DOCKERY, LOVE,	*Love, Miss.*	Mrs. Rashleigh's.
DUBOIS, WILBUR FISK,	*Mobile, Ala.*	Mr. Cameron's.
EMLAW, HARLOW STIGAND,	*Grand Haven.*	Mr. Lord's.
ESSELSTYN, JOHN NELSON,	*Lansing.*	Mr. J. Edward's.
GREENE, FRED TURRELL,	*Berlin, Ontario.*	Mr. Thomas's.

Name.	Residence.	Room.
Holbert, Henry Hoffman,	*St. Clair.*	Mrs. Trim's.
Hooper, James Knight,	*Crystal Falls.*	Mrs. Brimacombe's.
Kent, Bamlet,	*Calumet.*	Hartman Block.
Martin, Nicholas John,	*Bessemer.*	Mr. Sparling's.
McDonald, Donald,	*Calumet.*	Mrs. Brimacombe's.
McIntyre, Charles,	*Lake Linden.*	Miss Jones's, Hancock.
Monroe, William Dearborn,	*Bath.*	Mrs. Cameron's.
Murray, Robert, Jr.,	*Lake Linden.*	Miss Kelly's
Orr, John Forest,	*L'Anse.*	Mr. J. McCurdy's.
Paull, Stephen, Jr.,	*Calumet.*	Mr J. McCurdy's.
Rashleigh, William John,	*Houghton.*	Mrs. Rashleigh's.
Rose, Robert Seldon,	*Fond du Lac, Wis.*	Keweenaw Club.
Rowe, David Prescott,	*Chicago, Ill.*	Mrs. Dallmeyer's.
Schumann, Adolph Enrique,	*Santiago de Cuba, Cuba.*	Mrs. Mitchell's.
Slock, George,	*Houghton.*	Mr Slock's.
Sweet, Roy William,	*Iron Mountain.*	Miller's Hotel.
Upham, William Erastus,	*Duluth, Minn.*	Mrs. Burrows's.
Wearne, William, Jr.,	*Red Jacket.*	Mr. McCurdy's.
Webb, Frederick Merklee,	*River Edge, N. J.*	Mr. Lange's.
Wood, Robert John,	*Cleveland, Ohio.*	Dallmeyer Block.
Wright, Louis Aldro,	*Villa de Musquiz,* *Coahuila, Mexico.*	Keweenaw Club.
Wyckoff, Fred Carlton,	*Jacobsville.*	Mr. Chandler's.

SPECIAL STUDENTS.

Name.	Residence.	Room.
Beeler, Henry Christian, Field Geology.	*Denver, Colo.*	Butterfield House.
Benson, John Sydney, Chemistry and Mineralogy.	*Wardner, Idaho.*	Mr. Livermore's.
Burton, Warren Edward, Chemistry.	*Geneva Lake, Wis.*	Douglass House.
Crockard, Frank Hearne, Surveying.	*Wheeling, W. Va.*	Keweenaw Club.
Croze, Charles Edward, Shop Practice.	*Houghton.*	Mr. Croze's.
Cruse, James Alfred, Mathematics and Drawing.	*Red Jacket.*	Mrs. Brimacombe's.
Goodell, Horatio Stewart, Shop Practice.	*Houghton.*	Mr. Goodell's.
Gooding, Louis Ebenezer, Surveying.	*Berkeley, California.*	Mrs. Brimacombe's.
James, Houghton Edward, Chemistry.	*Duluth, Minnesota.*	Mrs. Healy's.
Maginn, John Biglin, Surveying.	*Germantown, Philadelphia, Pennsylvania.*	Mr. J. Edwards.
Oppen, William Adolph, Chemistry.	*Milwaukee, Wis.*	Mr. Livermore's.
Ross, George Edward, Chemistry.	*Hancock.*	Mr. Ross's.

Name.	Residence.	Room.
Seaman, Arthur Edmund, Petrography.	*Houghton.*	Mr. Seaman's.
Silliman, Henry Dickinson, Mathematics and Chemistry.	*Hudson, Wis.*	Mrs. Burrows's.
Stevens, Robert Clark, Surveying.	*Malone, N. Y.*	Mr. C. Brand's.
Watson, John Bone, Geology.	*Opechee.*	Mrs. Brimacombe's.

REGISTER OF STUDENTS

1893-1894.

GRADUATE STUDENTS.

Name.	Residence.	Room.
Baldwin, Walter John, S. B. (University of Michigan), Chemistry, Mineralogy and Petrography.	*Houghton.*	Keweenaw Club.
Harris, Herbert Jean, S. B. (University of Wisconsin), Chemistry, Ore Dressing, Mechanical and Electrical Engineering and Mineralogy.	*Waupun, Wis.*	Mr. Kroll's.
Williams, Herbert Baldwin, S. B. (University of Illinois), Chemistry, Metallurgy, Mineralogy, Petrography and Graphical Statics.	*Streator, Ill.*	Mrs. Dallmeyer's.
Carpenter, Alvin Bacon, Ph. B. (Beloit College), Surveying.	*Beloit, Wis.*	Mr. John Edwards's,

CLASS OF 1894.

Name.	Residence.	Room.
Burrall, Frederick Peck,	*Battle Creek.*	Club of '94.
Cameron, Donald,	*St. Louis.*	Mrs. P. Didier's.
Cranson, Robert Edward,	*St. Johns.*	Club of '94.
Durfee, Elmer Whipple,	*Grand Rapids.*	Mrs. Alford's.
Eby, John Henry, A. B. (Franklin and Marshall College),	*Lancaster, Pa.*	Mrs. Alford's.
Jones, Maurice Lindley,	*Benton Harbor.*	Mr. Kroll's.
Kirchen, John George,	*Lake Linden.*	Mr. Kroll's.
Knight, John Alexander,	*Ionia.*	Miss Jones's, Hancock.
McDonald, William Neal,	*Houghton.*	Mr. McDonald's.
McFarlane, George Campbell,	*Bay City.*	Mrs. Beard's.
Mason, Clarence George,	*Hancock.*	Mr. W. H. Mason's, Hancock.
Mason, Russell Teel,	*Boulder, Colo.*	Mrs. C. Didier's.
Moore, Carlton Franklin,	*Marquette.*	Mr. Sparling's.
Ridley, Frederick William,	*Newcastle-on-Tyne, Eng.*	Mrs. E. M. Hoar's.
Rourke, Jerry,	*Hancock.*	Mr. Rourke's, Hancock.
Seeley, Burton Tyndall,	*Genessee Township.*	Mr. Sparling's.
Stringham, Joseph, Jr.,	*Saginaw.*	Club of '94.
Tower, Louis Lovell,	*Ionia.*	Mrs. Rice's.
Watson, John Bone,	*Opechee.*	Mrs. Brimacombe's.
Wraith, William,	*Newcastle, Colo.*	Mrs. Dallmeyer's.

CLASS OF 1895.

Name.	Residence.	Room.
Barlow, Royce Elwin,	*Hastings.*	Mr. James Thomas's.
Barstow, George Mitchell,	*Detroit.*	Mrs. Beard's.
Bates, Armand Walter,	*Ironwood.*	Mr. Schnitzer's.
Been, John Theodore,	*Skanee.*	Mr. Cameron's.
Cameron, William,	*St. Louis.*	Mr. C. Mills's.
Coleman, Milton Watson,	*Calumet.*	Dallmeyer Block.
Davis, Carl Raymond,	*Helena, Montana.*	Mr. C. Pryor's.
Dockery, Love,	*Love, Miss.*	Mr. Cameron's.
DuBois, Wilbur Fisk,	*Mobile, Alabama.*	Mr. C. Brand's.
Emlaw, Harlan Stigand,	*Grand Haven.*	Mr. C. Brand's.
Hardenburg, Louis Martin, A. B. (Hillsdale College),	*Tecumseh.*	Mrs. Burrows's.
Holbert, Henry Hoffman,	*St. Clair.*	Club of '94.
Kent, Bamlet,	*Houghton.*	Dallmeyer Block.
Martin, Nicholas John,	*Bessemer.*	Mrs. Dallmeyer's.
Munroe, William Dearborn,	*Bath.*	Mr. Cameron's.
Murray, Robert, Jr.,	*Lake Linden.*	Miss Kelly's.
Orr, John Forest,	*L'Anse.*	Mrs. Burrows's.
Rose, Robert Selden,	*Fond du Lac, Wis.*	Keweenaw Club.

SCHUMANN, ENRIQUE ADOLPHO,	*Santiago de Cuba, Cuba.* Mr. James Thomas's.
SLOCK, GEORGE,	*Houghton.* Mr. Slock's.
UPHAM, WILLIAM ERASTUS,	*Duluth, Minn.* Mr. James Thomas's.
WEARNE, WILLIAM, JR.,	*Red Jacket.* Mrs. Burrows's.
WEBB, FREDERICK MERKLEE,	*River Edge, N. J.* Mr. Lange's.
WRIGHT, LOUIS ALDRO,	*Villa de Musquiz,* *Coahuila, Mexico.* Keweenaw Club.
WYCKOFF, FRED CARLTON,	*Jacobsville.* Mr. Schnitzer's.

FRESHMAN CLASS.

ALDRICH, WILLIAM IRVING,	*Coldwater.*	Butterfield House.
BEARD, WILLIAM HENRY,	*Stafford, England.*	Mr. Harrington's.
CROZE, LAWRENCE LUDGER,	*Houghton.*	Mr. J. Croze's.
FIGUEROA, CAMILO, A. B. (St. Mary's College),	*Saltillo, Coahuila, Mexico.*	Mr. Livermore's.
HOAR, FREDERIC WALPOLE,	*Houghton.*	Mr. R. M. Hoar's.
HOULE, ALBERT JOSEPH,	*Negaunee.*	Mr. Pummerville's.
McDONALD, DONALD,	*Calumet.*	Mrs. Brimacombe's.
PATRICK, JOHN CUTHBERT,	*Detroit.*	Mrs. Brimacombe's.
RASHLEIGH, WILLIAM JOHN,	*Houghton.*	Mrs. Rashleigh's.
RUSSELL, EDWARD FRANCIS,	*Yonkers, N. Y.*	Mr. C. Brand's.
SMITH, WILLARD JOSEPH,	*Allouez.*	Mrs. Livermore's.
SWEET, ROY WILLIAM,	*Iron Mountain.*	Mr. Pfeiffer's.
TRETHEWEY, JAMES HENRY,	*South Lake Linden.*	Butterfield House.
WALKER, ELTON WILLARD,	*Detroit.*	Mrs. Brimacombe's.

SPECIAL STUDENTS.

Name.	Residence.	Room.
Boyd, Frederick James, Physics and Surveying.	*Dollar Bay, Mich.*	Mr. Berg's.
Calhoun, Charles Andrew, Mathematics, Drawing, Chemistry, Metallurgy and Petrography.	*Albert Mines, Albert Co., N. B.*	Dallmeyer Block.
Coggin, Frederick Griswold, Jr., Chemistry, Metallurgy, Ore Dressing and Mineralogy.	*Denver, Col.*	Mr. Coggin's, Lake Linden.
Crockard, Frank Hearne, Physics, Metallurgy, Mineralogy, Mechanical and Electrical Engineering.	*Wheeling, W. Va.*	Keweenaw Club.
Croze, Charles Edward, Shop Practice.	*Houghton.*	Mr. Croze's.
Esselstyn, John Nelson, Drawing, Chemistry and Mineralogy.	*Lansing.*	Mr. J. Edwards's.
Fesing, Ernest, Shop Practice.	*Houghton.*	Mr. Fesing's.
Floeter, Albert Henry Christopher, Mathematics, Physics, Drawing and Chemistry.	*Menominee.*	Mr. Peiffer's.
Hooper, James Knight, Mathematics, Drawing and Chemistry.	*Crystal Falls.*	Mr. C. Brand's.

JEFFERS, FRED ALFRED,
Mineralogy. *Atlantic Mine.*
Mr. Peter Thomas's.

JAMES, HOUGHTON EDWARD.
Chemistry. *Duluth, Minn.*
Mrs. James Healey's.

KNOX, JOHN,
Chemistry. *Hamilton, Ontario.*
Mr. Shafer's.

LEE, ROBERT ERWIN,
Mathematics, Drawing, Chemistry and Surveying. *Rock Island, Ill.*
Mr. Lange's.

McCORMICK, EDWARD PATRICK,
Drawing, Graphical Statics, Chemistry, Metallurgy, Ore Dressing and Electrical Engineering. *Calumet.*
Mrs. Burrow's.

NEWTON, LEE LUKE,
Mineralogy, Graphical Statics, Assaying, Ore Dressing and Mechanical and Electrical Engineering. *Lake Linden.*
Mrs. Kelly's.

PARKS, HENRY JAMES,
Chemistry, Metallurgy and Mineralogy. *Lake Linden.*
Mr. Kroll's.

TRUETTNER, IRVING WILLARD,
Mathematics, Physics, Drawing, and Chemistry. *Bessemer.*
Mrs. Dallmeyer's.

VAN ORDEN, FRANK LYON,
Shop Practice. *Houghton.*
Mr. W. Van Orden's.

WEBB, FRANCIS JOHN,
Physics. *Calumet.*
Mr. Charles Retallic's.

SUMMARY, 1892-1893.

Graduate Students	5
Class of 1893	14
Class of 1894	26
Class of 1895	40
Special Students	16
	101

BY COUNTRIES AND STATES.

Alabama		1
California		1
Canada		2
Colorado		3
Cuba		1
England		2
Idaho		1
Illinois		2
Indiana		1
Mexico		1
Michigan	Upper Peninsula 44 Lower Peninsula 20	64
Minnesota		2
Mississippi		1
Missouri		1
Montana		1
New Brunswick		1
New Jersey		1
New York		2
Ohio		3
Oregon		1
Pennsylvania		2
West Virginia		1
Wisconsin		6
		101

SUMMARY, 1893-1894.

Graduate Students	4
Class of 1894	20
Class of 1895	25
Class of 1896	14
Special Students	19
	82

BY COUNTRIES AND STATES.

Alabama	1
Canada	1
Colorado	3
Cuba	1
England	2
Illinois	2
Mexico	2
{ Upper Peninsula..........38 }	[illegible]
Minnesota	2
Mississippi	1
Montana	1
New Brunswick	1
New Jersey	1
New York	1
Pennsylvania	1
West Virginia	1
Wisconsin	8
	82

AVERAGE AGE OF STUDENTS.

1892–1893.

Special Students	24½ years.
Class of 1895	22 years.
Class of 1894	22 years.
Class of 1893	23½ years.
Graduate Students	27 years.
Average Age of all Students	23 years.

1893–1894.

Special Students	23 years.
Freshman Class	21 years.
Class of 1895	21 years.
Class of 1894	22 years.
Graduate Students	27 years.
Average Age of all Students	22 years.

REQUIREMENTS FOR ADMISSION.

Students entering the Michigan Mining School are divided into three classes as follows:

1. Graduate Students.	Enter by presentation of their Diplomas.
2. Regular Students.	1. Enter through examination at the Mining School. 2. Enter by presentation of special certificate of admission.
3. Special Students.	Enter upon presentation of evidence that they are prepared to do the work they desire to take.

The special details for entrance are given below under these three divisions.

GRADUATE STUDENTS.

Graduates of any high grade Scientific or Technical School, College, or University will be admitted on the presentation of their diplomas, to take special graduate instruction; but they must satisfy the Faculty that their previous course has been of a grade entitling them to the privileges they seek.

Those graduates who desire to enter upon the regular undergraduate work of the Mining School, for the purpose of obtaining the degree of Bachelor of Science, or that of Mining Engineer, at this institution, will have their diplomas received for admission to the first year. Such studies as these graduates have taken in other institutions will then be allowed them, in lieu of the same studies in the undergraduate course here; provided that each graduate presents a certificate from the institution from which he has graduated, that he has taken these studies, giving the rank he obtained in each study; but credit will be allowed for those parts only that the Faculty are satisfied are the real equivalents of the work in the Mining School.

The Mining School courses having been arranged expressly to prepare students to do their subsequent professional work, it is believed that the institution offers unusual facilities for advanced and graduate students to obtain such professional training as they wish; and the School will take extra pains to encourage and assist such students.

REGULAR STUDENTS

Admission by Examination.

All students (not graduates) who desire to enter the regular undergraduate courses of the Mining School by examination, will be examined in the following subjects:

ARITHMETIC AND METRIC SYSTEM: either Wentworth's High School, Ray's Higher, Olney's Practical, Robinson's Practical, or an equivalent.

ALGEBRA, THROUGH QUADRATIC EQUATIONS: either Wentworth's School, Olney's Complete, Robinson's Elementary, Loomis's Elements, Van Velzer and Slichter's School, or an equivalent. •

GEOMETRY--PLANE, SOLID AND SPHERICAL: either Davies's Legendre revised by Van Amringe, Wentworth's

New, Olney's Revised, Chauvenet's revised by Byerly, Peck's Manual, or an equivalent.

Book-keeping: Elements of Single and Double Entry: either Bryant and Stratton's, Mayhew's, or an equivalent.

Elementary Physics: either Gage's or Avery's Elements, or an equivalent.

Elements of Astronomy: either Newcomb's Popular or School, Young's High School, or an equivalent.

Conditions in Book-keeping and Astronomy are allowed in these requirements when necessary.

Entrance by Presentation of Certificate

Candidates who desire to enter by certificate are divided into two divisions *1st*, those eighteen years of age and upwards; and *2nd*, those under eighteen years of age.

1st. A candidate eighteen years of age or over may present a certificate from the superintendent or principal of any high school, academy or seminary in good standing, certifying that the candidate has studied not less than one year in that institution; has been examined under the direction of the superintendent or principal who has signed the certificate; and that the candidate has passed in *Arithmetic; Metric System; Algebra, through quadratic equations; Plane, Solid and Spherical Geometry; Book keeping; Elementary Physics;* and *Elements of Astronomy;* with a rank of not less than eighty-five on a scale of one hundred, in each and every study required for admission.

Conditions in Book-keeping and Astronomy are allowed when necessary.

2nd. Candidates for admission by certificate, who are under eighteen years of age, must present a certificate from the superintendent or principal of some reputable high school, academy or seminary, that they have completed one of the *regular courses* of study in that school and *have graduated*, obtaining a rank of not less than eighty-five in a scale of one hundred in each and every subject required for admission to the Mining School, and that the candidate's rank in all other studies in the school's prescribed course is not less than seventy-five for each and every one.

Conditions in Book-keeping and Astronomy are allowed when necessary.

All pupils admitted on certificate will be placed on probation, and afterwards dropped from the course, if on trial, they shall be found to be not properly qualified; and no certificate will be accepted afterwards from the teachers and schools improperly recommending such pupils.

The certificates to be presented shall be in the form given here, and blanks can be obtained on application to the Director, by letter or otherwise.

Students desiring to enter on certificate, instead of by examination, *must see* that their certificates conform to the one required here, as only certificates which do so conform will be received in place of an examination.

If the rank is given in some other form than the decimal scale, then it will be necessary for the officer signing the certificate to state what his marks are equivalent to in the decimal scale, if he wishes the certificate to be received at the Mining School.

CERTIFICATE FOR ADMISSION TO THE MICHIGAN MINING SCHOOL.

Of Mr. ....
Age of candidate...
Name of school ....
Name of principal or superintendent ....
Course taken...

I certify that Mr. .... graduated in the........................school under my charge; that he was examined in the following studies under my direction and that he obtained the marks set opposite each subject. I further certify that the examinations, to the best of my knowledge and belief, have been conducted fairly and honorably. I also certify that Mr. ....is of good moral character, that his attention to his duties has been .... and that his conduct has been ....

I also send with this a catalogue or schedule which will show the course of study taken by Mr. .... in this institution.

(Signed) ....

	Subjects.	Rank.
Required Studies.	Arithmetic	....
	Metric System	....
	Algebra, through Quadratics...	....
	Geometry, Plane	....
	Geometry, Solid	....
	Geometry, Spherical	....
	Astronomy	....
	Book-keeping	....
	Physics........................	....

Other studies taken to be given here, with the rank obtained:

....

....

....

....

UNDERGRADUATES OF OTHER INSTITUTIONS.

Undergraduates of any high grade Scientific and Technical School, College, or University, will be admitted to *the regular course in the Mining School, on the presentation of a certificate from the proper officers of that institution,* stating that said undergraduates have been regularly admitted to said school, etc.; that they have pursued their studies there for a specified length of time; that they have passed upon entrance or subsequently in the school in all the subjects required for admission to the Mining School; that their standing in the institution in question is good, and that they have been honorably dismissed at their own request.

If these undergraduates will also present proper certificates showing the ranks obtained in their respective institutions in such subjects as they have taken there, all studies which shall be found to be the real equivalents of the studies of the Mining School course will be accepted in lieu of the corresponding studies here, if the certificates presented shall show that they obtained a satisfactory rank not less than 75 per cent in those studies; provided that the application for the acceptance of their past work, as an equivalent for work in the Mining School, shall be made at the time that the students in question join the Mining School.

The examination for acceptance of work done in other institutions is not generally formal, but is of such a nature as enables the Faculty to ascertain if the work done is the equivalent of the work here, and that the student is sufficiently advanced to be allowed the credit he seeks.

Conditions in Astronomy and Book-keeping are allowed when necessary.

ENTRANCE CONDITIONS

No student will be admitted as a regular student with conditions in any other subjects than Astronomy and Book-keeping. The condition in Astronomy must be made up at the commencement of the winter term after entrance, and the condition in Book keeping by the commencement of the winter term of the third year.

In case of failure on the part of the student, without satisfactory excuse, to make up his conditions as required, he will be dropped from the school and not allowed to continue his work here until the conditions shall have been removed.

It is necessary for those who are preparing to take the regular course in the Mining School to give special attention to the Mathematics and Physics required for entrance, since a thorough working knowledge of the elements of these subjects is not only indispensable for entry upon the advanced work in them, but is very important in its relation to most of the other subjects taken, as Mathematics and Physics form a large part of the required preparation for successful work in the other studies of the course.

SPECIAL STUDENTS.

Persons of suitable age will be admitted as special students to take such studies as they may be found qualified to pursue, but they will be required to take sufficient work to occupy all the time that is at their disposal for school duties. This regulation will be departed from only for good and sufficient reasons in the case of persons of age and experience. In case any of these special students intend hereafter to take the full course and graduate, they should present, so far as practicable, the same certificates as those entering the regular course.

When these special or partial students are sufficiently advanced, so that they are enabled to do most of the work of a certain class, and expect shortly to become regular students and candidates for a degree, their names are generally given for convenience in the catalogue with those of the members of the class to which they most properly belong; the same as is done with the regular students who, owing to failure in one or more subjects, will not be able to graduate with the class with which they entered.

THE COURSE OF INSTRUCTION.

The Michigan Mining School offers two courses of study in Mining Engineering:

1st. One three years in length leading to the degree of Bachelor of Science.

2nd. The other four years in length, leading to the degree of Engineer of Mines.

The first course covers the ordinary work of a Mining Engineer, while the second course is intended to prepare one for the higher and more specialized work in Engineering.

The former three years' course will be discontinued in 1895, except so far as it may be necessary to continue some portions of it in 1896, to enable some students to graduate who entered with the class of 1895, but who from sickness or other causes have been obliged to fall behind. No new students will be allowed to take this course, unless they are fully prepared to enter and graduate with the class of 1895.

The first three years of the new three and four years' courses are identical, enabling the student to graduate at the end of his third or fourth year, at his option, without loss of time.

The Michigan Mining School is not a college, nor an undergraduate school—it is kept strictly as a *professional* school of high grade, in which it is intended to give instruction to graduates and to others who desire a professional education.

The Michigan Mining School, like Theological, Law and

Medical schools, assumes that the student's preparatory and literary education has been completed prior to his entering upon his professional studies; and that he has taken up the work here for the purpose of preparing himself for his future life work. Like other professional schools, the Michigan Mining School urges all students intending to take their professional studies here to obtain previously an education of the broadest and most liberal character. This is necessary if the student wishes fully to profit by his studies here, and desires to take that high professional rank that should be the ultimate aim of every graduate.

Although not required, the student is advised to obtain before entering the school a reading knowledge of some of the important modern languages, as German, French, Swedish, and Spanish, and to have thoroughly studied subjects that will give him the requisite training in habits of close, accurate and logical reasoning, together with a good command of language, e. g., Psychology, Logic, Rhetoric, Literature, etc. Experience has shown that of two students of equal ability, the one that can give the time to obtain the best preparation, will in the end pass far beyond the one that has had the inferior training.

While it is preferred that students entering should have a liberal education, for their own advantage, the Mining School will not repel, but invites and will try to assist in every possible way, all those who have not been so fortunate, if they have the requisite knowledge and ability to profit by the course, and in conformity with this idea, it has confined its requirements for admission, in the case of those of sufficient age, to those subjects that are absolutely essential as a preparation for the required course, the same as is done in Law, Theological and Medical schools. So, too, the course of instruction is restricted to those subjects that are considered essential to the practical work of a Mining Engineer, since the school does not concern itself with anything except its legitimate business—*professional or technical education.*

In preparing the course of instruction, the effort has been made to contribute somewhat to the solution of one of the greatest educational problems of the age—properly to combine scientific or theoretical knowledge with practical training. In pursuance of this object it is intended that the student shall be well grounded in the principles or in the science of all the subjects he studies, while it is further proposed that he shall also obtain experience and practice in every subject taught, so far as the means and time at the disposal of the School will permit. That is, the student shall have an opportunity to observe and to verify in the laboratory, field, mill or mine, whatever he shall have learned in the class room.

Further, it is intended that the practical work shall here be carried to such an extent that the pupil can make use of it subsequently in his profession.

To this end, the course of instruction has been made as practical as possible, embodying as it does not only the experience of other Mining Schools, but also that of various leading practical mining men, who have been freely consulted concerning the things that they wish men to know in mining work.

The work in the course is extended and difficult, and requires a man's ability to accomplish it satisfactorily in the given time, as it is so strongly professional. In case, however, one is not able to do the work in the required time, he can readily arrange his work so as to take one or two more years for it.

In general, the instruction will be given by means of lectures, recitations, and laboratory and field practice, including the inspection of mills, mines and smelting works. Each student will receive individual instruction in the laboratories, and those qualified will be advised and directed in original investigations.

Every facility will be given to special and graduate students who desire to pursue any particular subject or subjects taught in the schools, provided they enter during the time when that subject or subjects are taught in their regular order.

In Mathematics, Physics, Drawing, Chemistry, Mineralogy, Petrography, Geology, etc., the instruction is so given that any one who desires a knowledge of any of these subjects,as a matter of general education, or as a preparation for teaching, or for some other profession than Mining Engineering, can profitably study here.

The amount of labor is so great in accomplishing the necessary work of the regular course in this institution in the given time, that every student needs to present himself promptly at the opening of the school year and remain until its close. Every regular student is required to spend seven hours a day for five days each week in laboratory or field work, or in recitation or lecture. He prepares for his recitations in time taken outside of these seven hours a day. When the work is of such a nature that comparatively little outside preparation is required, then eight or ten hours a day may be required in the shop, mill, field or laboratory, at the discretion of the instructor.

In order to enable such students, as can do the work in the required time, to graduate as soon as possible, and to give them the requisite amount of laboratory, shop and field practice, the course is extended over forty-five weeks a year. This can be readily done owing to the cool summer climate, and thus give in three or four years as much instruction as other institutions, having shorter years, can do in four or five years. This saves for the pupils of the Mining School one year of their time. As stated before, any man can extend his course over a longer period of time, if he desires, and in practice many do, since the daily work taxes fully the capacity of our best college and university graduates.

Since the instruction is largely personal, the maximum amount of work that can be done by each student is limited only by his time and ability, while in most of his studies he can advance as far and as rapidly as he is able to do consistently with good work.

Various excursions are taken to the mines, mills and smelting works in the vicinity, on Saturdays or on other days, as occasion may require. Some of these excursions are required and some are voluntary, and all students who join in them are under the direction of the instructor in charge, and are subject to discipline, the same as when in the laboratories of the school.

The laboratories and buildings are closed at 4 P.M. on Saturdays, and at 6 P.M. on other week days.

It is advised that no student should endeavor to enter the Mining School unless he is interested in the subjects taught, and intends to attend strictly to his business, since under these conditions alone will he be allowed to remain.

THE DEPARTMENTS OF INSTRUCTION.

I. MATHEMATICS AND PHYSICS.

Professor McNair and Mr. Davis.

- A. Mathematics.
  - 1, Advanced Algebra.
  - 2, Trigonometry, Plane and Spherical.
  - 3, Analytical Geometry.
  - 4, Calculus, Differential and Integral.
- B. Physics.
  - 1, Mechanics.
  - 2, Heat.
  - 3, Light.
  - 4, Electricity.
  - 5, Magnetism.
  - 6, Laboratory Work.
- C. Mechanics.
- D. Hydraulics.

II. CHEMISTRY AND METALLURGY.

Professor Koenig, Mr. .... and Mr. Seeley.

- A. Chemistry.
  - 1, General Chemistry.
  - 2, Blowpipe Analysis.
  - 3, Qualitative Analysis.
  - 4, Quantitative Analysis.
  - 5, Assaying.
  - 6, Synthetic Chemistry.
- B. Metallurgy.
  - 1, Theoretical Metallurgy.
  - 2, Metallurgical Experimentation.
  - 3, Metallurgical Engineering Designing.

III. MECHANICAL AND ELECTRICAL ENGINEERING.

Professor Kidwell and Mr. Moore.

A. Drawing.

1, Descriptive Geometry.
2, Topographical Drawing.
3, Isometric and Cabinet Projection.
4, Free-hand Sketching.

B. Mechanical Engineering.

1, Properties of Materials.
2, Mechanism.
3, Mechanics of Materials.
4, Engineering Appliances.
5, Steam Engineering.
6, Shop Practice.
7, Testing of Materials of Engineering.
8, Mechanical Engineering Designing.

C. Electrical Engineering.

1, Electrical Instruments and Measurements.
2, Electrical Engineering.
3, Laboratory Practice.

IV. CIVIL AND MINING ENGINEERING.

Professor . . . . . and Mr. Abbott.

1, Plane Surveying.
2, Railroad Surveying.
3, Mine Surveying.
4, Mining.
5, Mine Accounts.
6, Mining Engineering.
7, Engineering Construction.
8, Mining Engineering Designing.
9, Ore Dressing.
10, Practical Work (Mines, Mill and Field).

V. MINERALOGY, PETROGRAPHY AND GEOLOGY.

Director Wadsworth, Mr. Seaman and Mr. Wright.

A. Mineralogy.

1, Crystallography.
2, Physical Mineralogy.
3, Chemical Mineralogy.
4, Determinative Mineralogy.
5, Laboratory Practice.

B. Petrography.
  1, Microscopic Mineralogy.
  2, Macroscopic Lithology.
  3, Microscopic Lithology.
  4, Petrology.
  5, Laboratory Practice.

C. Biology.
  1, Botany.
  2, Zoology.
  3, Paleontology.
  4, Laboratory Practice.

D. Geology.
  1. Stratigraphical Geology.
  2, Physical Geology.
  3, Chemical Geology.
  4, Economic Geology.
  5, Field Geology.

OUTLINE OF THE THREE YEARS COURSE OF STUDY FOR THE DEGREE OF BACHELOR OF SCIENCE.

FIRST, OR FRESHMAN, YEAR.

Fall Term—Fourteen Weeks.

MATHEMATICS: Higher Algebra. Lectures and Recitations. Five hours a week.
Professor McNair.

MATHEMATICS: Plane Trigonometry. Lectures and Recitations. Two hours a week.
Professor McNair.

PHYSICS: Elementary Mechanics and Heat. Lectures, Recitations and Laboratory Work. Eight hours a week.
Professor McNair and Mr. Davis.

DRAWING: Drawing-instruments and Materials, Plane Geometrical Problems, Projection, Development, Intersection of Lines, Surfaces and Solids, Tinting, Lettering, Round Writing. Lectures and work in Drawing Room. Twelve hours a week.
Mr. Moore.

CHEMISTRY: General Principles and Non-metals. Lectures, Recitations and Laboratory work. Eight hours a week for eight weeks. Five hours a week for six weeks.

Professor Koenig, Mr. ——— ——— and Mr. Seeley.

SURVEYING: Lectures and Recitations. Three hours a week for six weeks.

Professor .

Winter Term—Fourteen Weeks.

MATHEMATICS: Spherical Trigonometry. Lectures and Recitations. Two hours a week.

Professor McNair.

MATHEMATICS: Analytic Geometry. Recitations. Five hours a week.

Professor McNair.

PHYSICS: Light, Electricity and Magnetism. Lectures, Recitations and Laboratory work. Eight hours a week.

Professor McNair and Mr. Davis.

DRAWING: Topographical Drawing; Making Scales, Platting, Topographical Signs. Lectures and work in the Drawing Room. Ten hours a week.

Professor ——— and Mr. Moore.

SURVEYING: Lectures and Recitations. Three hours a week.

Professor ———.

CHEMISTRY: General Principles and Elements. Lectures, Recitations and Laboratory work. Seven hours a week.

Professor Koenig, Mr. Seeley and Mr. ———.

Summer Term—Seventeen Weeks.

MATHEMATICS: Higher Algebra. Lectures and Recitations. Five hours a week for six weeks.
Professor McNair.

MATHEMATICS: Analytic Geometry. Recitations. Five hours a week for six weeks.
Professor McNair.

PHYSICS: Electricity and Magnetism. Lectures, Recitations and Laboratory work. Ten hours a week for six weeks.
Professor McNair and Mr. Davis.

CHEMISTRY: Blowpipe Analysis. Introduction to Qualitative Analysis. Lectures, Recitations and Laboratory work. Twenty hours a week for six weeks.
Professor Koenig, Mr. Seeley and Mr.————.

SURVEYING: Plane, Topographical and Railroad Surveying. Lectures, Recitations, and Practical work in the Field and Drawing Room. Forty-five hours a week for eleven weeks.
Mr. Abbott and Mr. Davis.

SECOND, OR SOPHOMORE, YEAR.

Fall Term—Fourteen Weeks.

MATHEMATICS: Differential and Integral Calculus. Lectures and Recitations. Five hours a week.
Professor McNair.

DRAWING: Descriptive Geometry, Lettering and Construction Drawing from Rough Sketches and Models. Lectures, and work in Drawing Room. Four hours a week.
Mr. Moore.

CHEMISTRY: Qualitative Analysis. Recitations and Laboratory work. Eight hours a week.
Professor Koenig, Mr. Seeley and Mr. ———.

BOTANY: Lectures and Recitations. Two hours a week for eight weeks.
The Director.

ZOOLOGY: Lectures and Recitations. Two hours a week for eight weeks.
Mr. Seaman.

PROPERTIES OF MATERIALS: Wrought and Cast Iron, Steel, Copper, Tin, Zinc, Antimony, Bismuth, Alloys, Timber, Brick, Mortar, Cements, etc. Lectures and Recitations. Two hours a week.
Mr. Moore.

MINING AND MINE SURVEYING: Lectures and Recitations. Four hours a week for six weeks.
Professor ————

MINERALOGY: Crystallography, Physical and Determinative Mineralogy. Lectures, Recitations and Laboratory work. Twelve hours a week.
The Director, Mr. Seaman and Mr. Wright.

Winter Term—Fourteen Weeks.

MATHEMATICS: Integral Calculus. Lectures and Recitations. Three hours a week.
Professor McNair.

MECHANICS: Analytical Mechanics. Lectures and Recitations. Four hours a week.
Professor McNair.

DRAWING: Machine Drawing, Tracing, Blue Printing, Making Drawings from Models. Lectures and work in Drawing Room. Four hours a week.
Mr. Moore.

CHEMISTRY: Qualitative and Quantitative Analysis. Lectures, Recitations and Laboratory work. Eight hours a week.
Professor Koenig, Mr.   and Mr. Seeley.

MINING AND MINE SURVEYING: Lectures and Recitations. Four hours a week.
Professor ———.

MINERALOGY: Physical and Determinative Mineralogy. Lectures, Recitations and Laboratory work. Twelve hours a week.
The Director, Mr. Seaman and Mr. Wright.

Summer Term—Seventeen Weeks.

MINING AND MINE SURVEYING: Practical work in the Mines. Forty-five hours a week for six weeks.
Professor ———— and Assistant.

ASSAYING: Lectures and Practical work. Forty-five hours a week for one week.

SHOPWORK: Practical work in Pattern and Machine Shops. Forty-five hours a week for ten weeks.
Professor Kidwell, Mr. Shields and Mr. Purfield.

THIRD, OR JUNIOR, YEAR.

Fall Term—Fourteen Weeks.

MECHANICS: Analytical Mechanics. Recitations. Two hours a week.
Professor McNair.

CHEMISTRY: Quantitative Analysis. Lectures, Recitations and Laboratory work. Ten hours a week.
Professor Koenig, Mr. and Mr. Seeley.

METALLURGY: Fuel, Refractory Materials, Iron, Steel and Aluminum. Lectures and Recitations. Five hours a week.
Professor Koenig.

MECHANISM: Laws of Motion, Linkwork, Cams, Teeth of Wheels, Aggregate Motion, etc. Lectures and Recitations. Three hours a week.
Mr. Moore.

MECHANICS OF MATERIALS: Application of Principles of Statics to Rigid Bodies, Elasticity and Resistance of Materials, Discussion of Beams, Columns and Shafts, Combined Stresses, Testing of Materials. Lectures and Recitations. Three hours a week.
Professor Kidwell.

MINING ENGINEERING: Lectures and Recitations. Four hours a week for six weeks.
Professor .

PALEONTOLOGY: Lectures, Recitations and Laboratory Work. Four hours a week for eight weeks.
Mr. Seaman.

PETROGRAPHY: Microscopic Mineralogy, Determinative Lithology. Lectures, Recitations and Laboratory work. Six hours a week.
The Director and Mr. Seaman.

PHYSICAL GEOLOGY: Lectures and Recitations. Two hours a week.
The Director.

Winter Term—Fourteen Weeks.

DRAWING: Lectures and work in Drawing Room. Four hours a week.
Professor Kidwell.

DRAWING: Graphical Statics; Analysis of Roof Trusses of various standard designs. Lectures and work in Drawing Room. Three hours a week.
Professor ———— and Mr. Moore.

METALLURGY: Copper, Lead, Silver and Gold. Lectures and Recitations. Three hours a week.
Professor Koenig.

MECHANICAL ENGINEERING, continued: Lectures and Recitations. Four hours a week.
Professor Kidwell.

ELECTRICAL ENGINEERING: Batteries, Ammeters, Orthometers, Electrical Measurements, Magnets, Electro-Magnetic Induction and Theory of the Dynamo. Lectures and Recitations. Three hours a week.
Professor Kidwell.

MINING ENGINEERING AND MINE ACCOUNTS: Lectures and Recitations. Four hours a week.
Professor .

PETROGRAPHY: Microscopic Mineralogy, Determinative Lithology, Petrology. Lectures, Recitations and Laboratory work. Six hours a week.
The Director and Mr. Seaman.

STRATIGRAPHICAL GEOLOGY: Lectures, Recitations and Laboratory work. Five hours a week.
Mr. Seaman.

PHYSICAL GEOLOGY: Lectures and Recitations. Three hours a week.
The Director.

Summer Term—Seventeen Weeks.

CHEMISTRY: Quantitative Analysis. Lectures, Recitations and Laboratory work. Forty-five hours a week for six weeks.

Professor Koenig, Mr. ...... and Mr. Seeley.

ASSAYING: Practical work in the Laboratory with Lectures and Recitations. Forty-five hours a week for two weeks.

Professor Koenig, Mr. ...... and Mr. Seeley.

MECHANICAL ENGINEERING: Practice in the Testing Laboratory. Forty-five hours a week for three weeks.

Professor Kidwell and Mr. Moore.

FIELD GEOLOGY: Practical work in the Field. Forty-five hours a week for six weeks.

The Director and Mr. Seaman.

GRADUATION.

OUTLINE OF THE FOUR YEARS COURSE OF STUDY FOR THE DEGREE OF ENGINEER OF MINES.

FIRST, OR FRESHMAN, YEAR.

Fall Term—Fourteen Weeks.

MATHEMATICS: Higher Algebra. Lectures and Recitations. Five hours a week.

Professor McNair.

MATHEMATICS: Plane Trigonometry. Lectures and Recitations. Two hours a week.

Professor McNair.

PHYSICS: Elementary Mechanics and Heat. Lectures, Recitations and Laboratory Work. Eight hours a week.

Professor McNair and Mr. Davis.

DRAWING: Drawing-instruments and Materials, Plane Geometrical Problems, Projection, Development, Intersection of Lines, Surfaces and Solids, Tinting, Lettering, Round Writing. Lectures and work in Drawing Room. Twelve hours a week.

Mr. Moore.

CHEMISTRY: General Principles and Elements. Lectures, Recitations and Laboratory Work. Eight hours a week for eight weeks. Five hours a week for six weeks.

Professor Koenig, Mr. Seeley and Mr. ________ .

SURVEYING: Lectures and Recitations. Three hours a week for six weeks.

Professor ________.

Winter Term—Fourteen.

MATHEMATICS: Spherical Trigonometry. Lectures and Recitations. Two hours a week.

Professor McNair.

MATHEMATICS: Analytic Geometry. Recitations. Five hours a week.

Professor McNair.

PHYSICS: Light, Electricity and Magnetism. Lectures, Recitations and Laboratory work. Eight hours a week.

Professor McNair and Mr. Davis.

DRAWING: Topographical Drawing: Making Scales, Platting, Topographical Signs. Lectures and work in the Drawing Room. Ten hours a week.

Professor .... and Mr. Moore.

SURVEYING:* Lectures and Recitations. Three hours a week.

Professor ....

CHEMISTRY: General Principles and Elements. Lectures, Recitations and Laboratory work. Seven hours a week.

Professor Koenig, Mr. ________ and Mr. Seeley.

Summer Term—Seventeen Weeks.

MATHEMATICS: Higher Algebra. Lectures and Recitations. Five hours a week for six weeks.

Professor McNair.

MATHEMATICS: Analytic Geometry. Recitations. Five hours a week for six weeks.

Professor McNair.

PHYSICS: Electricity and Magnetism. Lectures, Recitations and Laboratory work. Ten hours a week for six weeks.

Professor McNair.

CHEMISTRY: Blowpipe Analysis. Introduction to Qualitative Analysis. Lectures, Recitations and Laboratory work. Twenty hours a week for six weeks.

Professor Koenig, Mr. .... and Mr. Seeley.

SURVEYING: Plane, Topographical and Railroad Surveying. Lectures, Recitations, and Practical work in the Field and Drawing Room. Forty-five hours a week for eleven weeks.

Mr. Abbott and Mr. Davis.

SECOND, OR SOPHOMORE, YEAR.

Fall Term—Fourteen Weeks.

MATHEMATICS: Differential and Integral Calculus. Recitations. Five hours a week.

Professor McNair.

DRAWING: Descriptive Geometry, Lettering and Construction Drawing from Rough Sketches and Models. Lectures, and work in Drawing Room. Four hours a week.

Mr. Moore.

CHEMISTRY: Qualitative Analysis. Recitations and Laboratory work. Eight hours a week.

Professor Koenig, Mr. ———— and Mr. Seeley.

BOTANY: Lectures and Recitations. Two hours a week for eight weeks.

The Director.

ZOÖLOGY: Lectures and Recitations. Two hours a week for eight weeks.

Mr. Seaman.

PROPERTIES OF MATERIALS: Wrought and Cast Iron, Steel, Copper, Tin, Zinc, Antimony, Bismuth, Alloys, Timber, Brick, Mortar, Cements, etc. Lectures and Recitations. Two hours a week.

Mr. Moore.

MINING AND MINE SURVEYING: Lectures and Recitations. Four hours a week for six weeks.

Professor —

MINERALOGY: Crystallography, Physical and Determinative Mineralogy. Lectures, Recitations and Laboratory work. Twelve hours a week.
The Director, Mr. Seaman and Mr. Wright.

Winter Term—Fourteen Weeks.

MATHEMATICS: Integral Calculus. Lectures and Recitations. Three hours a week.
Professor McNair.

MECHANICS: Analytical Mechanics. Lectures and Recitations. Four hours a week.
Professor McNair.

DRAWING: Machine Drawing, Tracing, Blue Printing, Making Drawings from Models. Lectures and work in Drawing Room. Four hours a week.
Mr. Moore.

CHEMISTRY: Qualitative and Quantitative Analysis. Lectures, Recitations and Laboratory work. Eight hours a week.
Professor Koenig, Mr. and Mr. Seeley.

MINING AND MINE SURVEYING: Lectures and Recitations. Four hours a week.
Professor ——.

MINERALOGY: Physical and Determinative Mineralogy. Lectures, Recitations and Laboratory work. Twelve hours a week.
The Director, Mr. Seaman and Mr. Wright.

Summer Term—Seventeen Weeks.

Mining and Mine Surveying: Practical work in the Mines. Forty-five hours a week for six weeks.
Professor ———— and Assistant.

Assaying: Lectures and Practical work. Forty-five hours a week for one week.
Professor Koenig and Mr. Seeley.

Shopwork: Practical work in Pattern and Machine Shops. Forty-five hours a week for ten weeks.
Professor Kidwell, Mr. Shields and Mr. Purfield.

THIRD, OR JUNIOR, YEAR.

Fall Term—Fourteen Weeks.

Mechanics: Recitations. Two hours a week.
Professor McNair.

Chemistry: Quantitative Analysis. Lectures, Recitations and Laboratory work. Ten hours a week.
Professor Koenig, Mr.   and Mr. Seeley.

Metallurgy: Fuel. Refractory Materials. Iron, Steel and Aluminum. Lectures and Recitations. Five hours a week.
Professor Koenig.

Mechanism: Laws of Motion, Linkwork, Cams, Teeth of Wheels, Aggregate Motion, etc. Lectures and Recitations. Three hours a week.

Mr. Moore.

Mechanics of Materials: Application of Principles of Statics to Rigid Bodies, Elasticity and Resistance of Materials, Discussion of Beams, Columns and Shafts, Combined Stresses, Testing of Materials. Lectures and Recitations. Three hours a week.

Professor Kidwell.

Mining Engineering: Lectures and Recitations. Four hours a week for six weeks.

Professor Denton.

Paleontology: Lectures, Recitations and Laboratory Work. Four hours a week for eight weeks.

Mr. Seaman.

Petrography: Microscopic Mineralogy, Determinative Lithology. Lectures, Recitations and Laboratory work. Six hours a week.

The Director and Mr. Seaman.

Physical Geology: Lectures and Recitations. Two hours a week.

The Director.

Winter Term—Fourteen Weeks.

Drawing: Lectures and work in Drawing Room. Four hours a week.

Professor Kidwell and Mr. Moore.

DRAWING: Graphical Statics: Analysis of Roof Trusses of various standard designs. Lectures and work in Drawing Room. Three hours a week.
Professor and Mr. Moore.

METALLURGY: Copper, Lead, Silver and Gold. Lectures and Recitations. Three hours a week.
Professor Koenig.

MECHANICAL ENGINEERING: Lectures and Recitations. Four hours a week.
Professor Kidwell.

ELECTRICAL ENGINEERING: Batteries, Ammeters, Orthometers, Electrical Measurements, Magnets, Electro-Magnetic Induction and Theory of the Dynamo. Lectures and Recitations. Three hours a week.
Professor Kidwell.

MINING ENGINEERING AND MINE ACCOUNTS: Lectures and Recitations. Four hours a week.
Professor .

PETROGRAPHY: Microscopic Mineralogy, Determinative Lithology, Petrology. Lectures, Recitations and Laboratory work. Six hours a week.
The Director and Mr. Seaman.

STRATIGRAPHICAL GEOLOGY: Lectures, Recitations and Laboratory work. Five hours a week.
Mr. Seaman.

PHYSICAL GEOLOGY: Lectures and Recitations. Three hours a week.
The Director.

Summer Term—Seventeen Weeks.

Chemistry: Quantitative Analysis. Lectures, Recitations and Laboratory work. Forty-five hours a week for six weeks.

Professor Koenig, Mr. and Mr. Seeley.

Assaying: Practical work in the Laboratory with Lectures and Recitations. Forty-five hours a week for two weeks.

Professor Koenig, Mr. and Mr. Seeley.

Mechanical Engineering: Practice in the Testing Laboratory. Forty-five hours a week for three weeks.

Professor Kidwell and Mr. Moore.

Field Geology: Practical work in the Field. Forty-five hours a week for six weeks.

The Director and Mr. Seaman.

FOURTH, OR SENIOR YEAR.

Fall Term—Fourteen Weeks.

Metallurgy: Lectures and Recitations. Five hours a week.

Professor Koenig.

Metallurgy: Metallurgical Experimentation. Laboratory work. Eight hours a week.

Professor Koenig.

MECHANICAL ENGINEERING: The Steam Engine and Allied Subjects. Lectures and Recitations. Five hours a week.

Professor Kidwell.

MECHANICAL ENGINEERING DESIGNING: Designing Columns, Beams, Floors, Trestles, Flumes, Steam Piping, etc. Lectures and work in Drawing Room. Nine hours a week.

Professor Kidwell and Mr. Moore.

ELECTRICAL ENGINEERING: Motors and their Applications, Storage Batteries, Arc and Incandescent Lamps, Wiring, Electrical Fittings, etc. Lectures and Recitations. Three hours a week.

Professor Kidwell.

ECONOMIC GEOLOGY. Lectures and Recitations. Five hours a week.

The Director.

Winter Term—Fourteen Weeks.

HYDRAULICS: Recitations. Four hours a week.

Professor McNair.

ORE DRESSING. Lectures and Recitations. Three hours a week.

Professor .

MECHANICAL ENGINEERING: The Steam Engine continued, Steam Boilers, Fuel, Steam Pumps. Lectures and Recitations. Four hours a week.

Professor Kidwell.

ENGINEERING APPLIANCES: Pumps, Gauges, Lubricators, Safety Valves, Fuel Heaters, etc. Lectures and Recitations. One hour a week.
Mr. Moore.

ELECTIVE,

Either

SYNTHETIC CHEMISTRY: Library and Laboratory work. Twenty-three hours a week.
Professor Koenig.

Or

METALLURGICAL DESIGNING: Work in the Drawing Room. Seven hours a week.
Professor Koenig and Mr. Moore.

ELECTRICAL ENGINEERING: Motors and their applications, Storage Batteries, Arc and Incandescent Lamps, Wiring, Electrical Fittings, etc., continued. Lectures and Recitations. Two hours a week.
Professor Kidwell.

MINING ENGINEERING DESIGNING: Designing Shaft Houses, Rock Houses, Mine Plants, Laying out Locations, etc. Work in the Drawing Room. Nine hours a week.
Professor ... and Mr. Moore.

ECONOMIC GEOLOGY. Lectures and Recitations. Five hours a week.
The Director.

Summer Term—Seventeen Weeks.

METALLURGICAL EXPERIMENTATION: Laboratory work. Forty-five hours a week for seven weeks.
Professor Koenig, Mr. and Mr. Seeley.

ORE DRESSING: Practical work in the Stamp Mill. Forty-five hours a week, four weeks.
Professor______ and Assistant.

MECHANICAL ENGINEERING: Practice in the Testing Laboratory. Forty-five hours a week, six weeks.
Professor Kidwell and Mr. Moore.

THESIS.

GRADUATION.

OUTLINE OF THE COURSE OF STUDY FOR THE CLASS OF 1895 FOR THE DEGREE OF ENGINEER OF MINES.

FIRST YEAR.

Fall Term—Fourteen Weeks.

MATHEMATICS: Higher Algebra. Lectures and Recitations. Five hours a week.

Professor McNair.

MATHEMATICS: Plane Trigonometry. Lectures and Recitations. Two hours a week.

Professor McNair.

PHYSICS: Elementary Mechanics and Heat. Lectures and Recitations. Three hours a week.

Professor McNair.

DRAWING: Drawing Instruments and Materials, Plane Geometrical Problems, Projection, Development, Round Writing. Lectures and work in Drawing Room. Ten hours a week.

Mr. Abbott.

CHEMISTRY: General Principles and Non-Metals, Blowpipe Analysis. Lectures, Recitations and Laboratory work. Four hours a week.

Professor Koenig.

MINERALOGY: Crystallography and Determinative Mineralogy. Lectures, Recitations and Laboratory work. Eleven hours a week.
The Director and Mr. Seaman.

Winter Term—Fourteen Weeks.

MATHEMATICS: Spherical Trigonometry. Lectures and Recitations. Two hours a week.
Professor McNair.

MATHEMATICS: Analytic Geometry. Recitations. Five hours a week.
Professor McNair.

PHYSICS: Light, Electricity and Magnetism. Lectures and Recitations. Three hours a week.
Professor McNair.

DRAWING: Intersection of Lines, Surfaces and Solids, Tinting. Lettering, Round Writing. Lectures and work in the Drawing Room. Eight hours a week for six weeks.
Mr. Abbott.

DRAWING: Topographical Drawing, Making Scales, Platting, Topographical Signs. Lectures, and work in the Drawing Room. Eight hours a week for eight weeks.
Professor Denton and Mr. Abbott.

CHEMISTRY: Metals. Lectures, Recitations and Laboratory work. Four hours a week.
Professor Koenig.

SURVEYING: Lectures and Recitations. Two hours a week.

Professor Denton.

MINERALOGY, DETERMINATIVE: Lectures, Recitations and Laboratory work. Eleven hours a week.

The Director and Mr. Seaman.

Spring Term Six Weeks.

MATHEMATICS: Analytic Geometry. Recitations. Five hours a week.

Professor McNair.

PHYSICS: Recitations and Practical Laboratory work. Fifteen hours a week.

Professor McNair.

CHEMISTRY: Introduction to Qualitative Analysis. Recitations and Laboratory work. Fifteen hours a week.

Professor Koenig and Mr. Moore.

Summer Term Eleven Weeks.

SURVEYING: Plane, Topographical and Railroad Surveying. Lectures, Recitations and practical work in the Field and Drawing Room. Five days a week.

Mr. Abbot and Mr. Davis.

SECOND YEAR.

Fall Term—Fourteen Weeks.

MATHEMATICS: Differential and Integral Calculus. Lectures and Recitations. Five hours a week.
Professor McNair.

DRAWING: Descriptive Geometry, Lettering and Construction Drawing from Rough Sketches and Models. Lectures, and work in Drawing Room. Six hours a week.
Mr. Abbott.

CHEMISTRY: Qualitative Analysis. Recitations and Laboratory work. Twelve hours a week.
Professors Koenig and Sharpless.

METALLURGY: Fuel, Refractory Materials, Iron, Steel and Aluminum. Lectures and Recitations. Four hours a week.
Professor Sharpless.

PETROGRAPHY: Optical and Microscopic Mineralogy, Determinative Lithology. Lectures, Recitations and Laboratory work. Eight hours a week.
The Director.

Winter Term—Fourteen Weeks.

MATHEMATICS: Integral Calculus. Lectures and Recitations. Two hours a week.
Professor McNair.

MECHANICS, ANALYTICAL: Recitations. Five hours a week.
Professor McNair.

DRAWING: Machine Drawing, Tracing, Blue Printing, Making Drawings from Models. Lectures and work in Drawing Room. Four hours a week.

Mr. Abbott.

CHEMISTRY: Qualitative and Quantitative Analysis. Recitations and Laboratory work. Ten hours a week.

Professors Koenig and Sharpless.

PROPERTIES OF MATERIALS: Wrought and Cast Iron, Steel, Copper, Tin, Zinc, Antimony, Bismuth, Alloys, Timber, Brick, Mortar, Cements, etc. Lectures and Recitations. Two hours a week.

Mr. Abbott.

MECHANISM: Laws of Motion, Linkwork, Cams, Teeth of Wheels, Aggregate Motion, etc. Lectures and Recitations. Three hours a week.

Mr. Abbott.

MINING AND MINE SURVEYING: Lectures and Recitations. Four hours a week.

Professor Denton.

STRATIGRAPHICAL GEOLOGY AND PALEONTOLOGY: Lectures, Recitations and Laboratory Work. Five hours a week.

Mr. Seaman.

Summer Term—Seventeen Weeks.

MINE SURVEYING AND MINING: Practical work in the Mines. Five days a week for six weeks.

Professor Denton and Mr. Abbott.

SHOPWORK: Practical work in Pattern and Machine Shops. Forty-five hours a week for eleven weeks.

Professor Kidwell, Mr. Shields and Mr. Purfield.

THIRD YEAR.

Fall Term—Fourteen Weeks.

DRAWING: Graphical Statics: Analysis of Roof Trusses of various standard designs. Lectures, and work in Drawing Room. Four hours a week.

Mr. Abbott.

CHEMISTRY: Quantitative Analysis. Lectures, Recitations and Laboratory work. Ten hours a week.

Professor Koenig.

METALLURGY: Copper and Lead. Lectures and Recitations. Three hours a week.

Professor Sharpless.

ORE DRESSING: Lectures and Recitations. One hour a week.

Professor Sharpless.

MECHANICS OF MATERIALS: Application of Principles of Statics to Rigid Bodies, Elasticity and Resistance of Materials, Discussion of Beams, Columns and Shafts, Combined Stresses, Testing of Materials. Lectures and Recitations. Three hours a week.

Professor Kidwell.

MECHANICAL ENGINEERING: The Steam Engine and Allied Subjects. Lectures and Recitations. Five hours a week.

Professor Kidwell.

Electrical Engineering: Batteries, Ammeters, Orthometers, Electrical Measurements, Magnets, Electro-Magnetic Induction and Theory of the Dynamo. Lectures and Recitations. Four hours a week.

Professor Kidwell.

Physical Geology: Lectures and Recitations. Five hours a week.

The Director.

Winter Term—Fourteen Weeks.

Drawing: Designing, Floors, Trestles, Flumes, Steam Piping, Arrangement of Steam Plants. Lectures, and work in the Drawing Room. Four hours a week.

Professor Kidwell.

Chemistry: Metallurgical Analysis. Recitations and Laboratory work. Seven hours a week.

Professors Koenig and Sharpless.

Metallurgy: Lead, Silver and Gold. Lectures and Recitations. Two hours a week.

Professor Sharpless.

Ore Dressing: Lectures and Recitations. One hour a week.

Professor Sharpless.

Mechanical Engineering: The Steam Engine continued, Steam Boilers, Fuel, Steam Pumps. Lectures and Recitations. Four hours a week.

Professor Kidwell.

ENGINEERING APPLIANCES: Gauges, Lubricators, Safety Valves, Fuel Heaters, etc. Lectures and Recitations. One hour a week.

Mr. Abbott.

ELECTRICAL ENGINEERING: Motors and their Applications, Storage Batteries, Arc and Incandescent Lamps, Wiring, Electrical Fittings, etc. Lectures and Recitations. Four hours a week.

Professor Kidwell.

MINING ENGINEERING AND MINE ACCOUNTS: Lectures and Recitations. Four hours a week.

Professor Denton.

HYDRAULIC AND STRUCTURAL ENGINEERING: Lectures and Recitations. Three hours a week.

Professor Denton.

ECONOMIC GEOLOGY. Lectures and Recitations. Five hours a week.

The Director.

Summer Term—Seventeen Weeks.

PREPARATION OF THESIS.

ASSAYING: Practical work in the Laboratory, with Lectures and Recitations. Forty-five hours a week for two weeks.

Professors Koenig and Sharpless and Mr. Trengove.

ORE DRESSING: Practical work in the Stamp Mill. Forty-five hours a week, four weeks.

Professor Sharpless.

FIELD GEOLOGY: Practical work in the Field. Forty-five hours a week, six weeks.

The Director, Mr. Seaman and Mr. Burrall.

GRADUATION

TABLE SHOWING NUMBER OF HOURS IN THE COURSES.

SUBJECTS	Three Years Course	Four Years Course		Three Years Course		Four Years Course			
						Division 1		Division 2	
		Division 1	Division 2	Theoretical Work	Practical Work	Theoretical Work	Practical Work	Theoretical Work	Practical Work
Mathematics	452	452	452	452		452		452	
Physics	284	284	284	68	216	68	216	68	216
Drawing	476	476	476		476		476		476
Chemistry	946	946	1268	270	676	270	676	298	970
Assaying	135	135	135		135		135		135
Metallurgy	112	707	609	112		221	486	207	402
Mechanical Engineering	753	1199	1199	168	585	434	765	434	765
Electrical Engineering	42	202	174	42		112	90	84	90
Surveying	555	555	555	75	480	75	480	75	480
Mining Engineering	472	598	472	160	312	160	438	160	312
Hydraulics		56	56			56		56	
Ore Dressing		222	222			62	160	62	160
Botany	16	16	16	16		16		16	
Zoology	16	16	16	16		16		16	
Mineralogy	336	336	336	52	284	52	284	52	284
Petrography	168	168	168	28	140	28	140	28	140
Geology	442	582	512	118	324	258	324	188	324
Total	5205	6950	6950	1577	3628	2280	4670	2196	4754

DEPARTMENTS OF INSTRUCTION.

MATHEMATICS.

PROFESSOR McNAIR.

As will be seen by a detailed examination of the following pages of this Catalogue, the subjects of this department form the necessary foundation for a great part of the student's subsequent work in his course; and they are taken as a preparation for this work, as well as for their value in actual engineering practice, and in affording mental discipline.

It is the intention, therefore, to give the instruction in this department in such a manner as will give prominence to those subjects or portions of subjects which will be of actual use to the student, and, later, to the engineer. It follows that many things, of interest only to the specialist in mathematics, are entirely omitted.

The value of the study of mathematics in developing the power to do vigorous and logical thinking is not lost sight of, but it is thought that the effort to master the logic of the subjects necessary to the engineer will afford the student ample opportunity to develop this power.

Every effort is made to see that the student takes advantage of the opportunity thus offered. At each step of his progress he is required to think. The ability to describe a given method, or to correctly quote a given formula, and to apply either to a given case, is in no instance accepted as sufficient. The student is required to logically derive the method or formula, and to rigidly demonstrate its correctness.

Attention is again called to the entrance requirements in this department. The intending student, whether he expects to enter on certificate from High School or not, is asked to pay particular attention to the subjects of Factoring, Fractions, Quadratic Equations, Radicals and Indices in Algebra, and to make sure of his understanding of and familiarity with each of them.

The work in mathematics is distributed as shown below:

ALGEBRA. *First Year*— Fall term, five hours a week. Summer term, five hours a week for six weeks.

The course includes the Theory of Limits, Logarithms, Progressions, Arrangements and Groups, and Binomial Theorem, in the Fall term. Undetermined Coefficients, Series, and the Solution of Higher Equations, are treated in the summer term.

Wentworth's College Algebra is used in '93-'94 as the text-book.

TRIGONOMETRY. *First Year*—Fall and winter terms, two hours a week.

The ratio system is used exclusively, and considerable prominence is given to the solution of trigonometric equations, and the transformation of trigonometric expressions.

Most of the time is devoted to *Plane Trigonometry*.

The Algebra of the fall term must precede or be taken along with this subject.

Wheeler's Plane and Spherical Trigonometry is used as the text-book.

ANALYTIC GEOMETRY. *First Year*—Winter term, five hours a week. Summer term five hours a week for six weeks.

The usual course is given, including the straight line and conic sections, with the transformation of co-ordinates, general equation of the second degree, and an introduction to higher plane curves and geometry of three dimensions.

The text-book is Wentworth's Analytic Geometry.

This subject must be preceded by the Algebra and Trigonometry of the fall term.

CALCULUS. *Second Year.*—Fall term, five hours a week. Winter term, three hours a week.

The *Differential Calculus* is developed with a rate as its fundamental notion. Throughout the course an effort is made to give the student a logical basis for his formulas, as well as a working knowledge of the subject. Applications to Expansion in Series, Indeterminate Forms, Maxima and Minima, Tangents, Normals, etc., are treated.

The *Integral Calculus* is from the start treated as a method of summation. Applications to problems of area, volume, etc., are taken up as soon as possible and their treatment is carried along with that of methods of integration.

The Calculus is given partly by lectures, with printed notes, and partly from Taylor's "Elements of the Calculus".

The Calculus must be preceded by the mathematics of the first year.

PHYSICS.

PROFESSOR McNAIR.

FIRST YEAR.—Fall and winter terms, eight hours a week; spring term, ten hours a week.

What is said above of the work in Mathematics, might, to a large extent, be repeated about that in the department of *Physics.* The aim is to select such subjects as have, directly or indirectly, a bearing on the practical work of the Mining Engineer.

The instruction is given by the laboratory method. The student goes at once into the laboratory, and there, under the direction of the instructors, investigates for himself, experimentally, the laws of *Mechanics, Heat, Light, and Electricity.* The experiments are mostly quantitative, and he is required to measure and give a definite account of the quantity with which he is dealing.

As far as possible, mere mechanical following of directions is excluded, and intelligent thinking is made necessary to the accomplishment of the work. Every effort is made to have the student clearly develop and fix in his mind the principles of *Physics* which he will afterward use, and also to lay the foundation for that skill in accurate determination of quantity, and care of delicate apparatus, which are needed by the practical engineer. Accuracy and order are insisted on from the first. Each student receives individual attention, and, with the exception of a few experiments requiring more than one observer, he does his work independently of all other students.

The laboratory work is accompanied by illustrated lectures, and by such text-book and recitation work as is found necessary.

Below is given a partial list of the equipment of this department for lecture illustration and laboratory work. Besides the apparatus here listed, the department possesses the usual outfit of battery cells, magnets, lenses, thermometers, and other minor apparatus.

Physical Apparatus.

2 sets of Apparatus for experimental demonstration of the laws of composition and resolution of forces.

12 Vernier Calipers.

12 Micrometer Calipers.

12 small Spherometers.

1 large Spherometer.

1 Cathetometer.

1 Atwood Machine.
1 large Gyroscope.
1 set Compound Pendulums.
1 Whirling Table and Accessories.
1 "Swiftest Descent" Apparatus.
6 sets Apparatus for determining Modulus of Elasticity.
6 Kohlbusch Balances.
1 Becker Balance.
1 Springer Torsion Balance.
6 Troemner Balances.
5 Jolly Balances.
1 Hydrostatic Balance.
4 Mohr Westphal Specific Gravity Balances.
24 Specific Gravity Bottles.
6 Nicholson's Hydrometers.
4 Baume Hydrometers.
1 Ritchie's Rotary Air Pump and Accessories.
1 Lever Air Pump.
1 Fortin's Barometer.
2 Aneroid Barometers.
2 Marriotte's Law Apparatus.
2 Condensing and Exhausting Pumps.
1 Condensing Pump and Cylinder.
1 Anemometer.
7 Sonometers.
6 Vibrating Forks and Resonaters.
1 Savart's Toothed Wheel Apparatus.
1 Lissajous Apparatus.
1 set Singing Flame Apparatus.
12 sets Apparatus for Velocity of Sound.
12 sets Apparatus for Calibrating Thermometer and Determining Specific Heats.
1 Pyrometer.
1 set Natterer Tubes.
1 Maximum and Minimum Thermometer.
1 Standard Centigrade Thermometer.

12 Calorimeters.
2 Glass Prisms, 8 in. and 6 in.
1 Achromatic Prism.
8 Spectra-Goniometers (Geneva).
12 Prisms for same.
1 Rowland Plane Grating.
1 Pair Tourmaline Tongs.
1 Table Polariscope.
1 Combined Projecting Microscope and Polariscope.
1 Newton's Rings Apparatus.
1 Bunsen Photometer.
3 Bradley's Marine Sextants.
1 Sextant with Artificial Horizon (Heath & Co.).
4 small Reading Telescopes with Stands and Scales.
8 large Reading Telescopes and Scales (Geneva).
1 Electro Magnet.
1 Electrophorus.
1 Toepler-Holtz Machine.
1 Gold Leaf Electroscope.
6 Leyden Jars.
4 Copper Voltameters.
6 Volume Voltameters.
4 sets Geissler Tubes.
1 Clamond's Thermo-Battery.
2 Thermopiles.
7 Astatic Galvanometers.
12 Calorimeters with Resistance Coils, for Determination of Galvanometer Constant.
4 Mirror Galvanometers, with interchangeable Coils of High and Low Resistance.
4 Mirror Galvanometers of High Resistance.
8 Dead-Beat Mirror Galvanometers (Hartman and Braun).
1 Reflecting D'Arsonval Galvanometer.
1 set of Shunts for same.
1 Reflecting D'Arsonval Differential Galvanometer.

1 Horizontal Magnet Desprez-D'Arsonval Galvanometer.

8 Tangent Galvanometers with High and Low Resistance Coils.

3 Tangent Galvanometers, Helmholtz-Gangain form.

1 Single Ring Tangent Galvanometer.

1 Foucault Apparatus.

1 set Primary and Secondary Coils.

1 small Induction Coil.

1 large Induction Coil.

5 Earth Inductors.

1 small Hand Dynamo.

5 small Electro-Motors.

2 British Association Standard Ohms.

1 Continuous Rheostat, Lord Kelvin's Form.

1 Kohlrausch Universal Rheometer.

1 British Association Bridge.

6 Pierce's Meter Bridges.

8 Box Whetstone Bridge and Resistance Sets, range 1-100 to 11,110 ohms.

1 Bradley's Complete Testing Apparatus. Range 1-5000 to 1111-10 ohms.

1 Standard Resistance Box and Bridge, Prof. Anthony's Form, Range 1-1000000 to 110,000,000 ohms.

MECHANICS.

PROFESSOR McNAIR.

SECOND YEAR.—Winter term, four hours a week.

THIRD YEAR.—Fall term, two hours a week.

Church's "Mechanics of Engineering", Parts I and II, Statics and Dynamics, is made the basis of this course.

An attempt is made to develop a few essential principles and to render the student proficient in applying them to practical rather than theoretical problems. To this end a large number of problems are solved, which so far as possible are selected from machines or structures with which the student is already familiar, or the study of which he is subsequently to take up.

The course in Physics, and the course in Mathematics except the Calculus of the winter term, second year, must precede the course in Mechanics. The Calculus of the winter term, second year, must accompany it.

HYDRAULICS.

PROFESSOR McNAIR.

FOURTH YEAR. Winter term, four hours a week.

This course is given mainly from Merriman's "Treatise on Hydraulics" as a text-book. It includes a study of water pressures; the flow of water through orifices, pipes and canals, and over weirs; the measurement of water power; and the structure and efficiency of the different sorts of water motors in actual use.

Particular attention is given to the latter two points, and to the solution of practical problems.

The complete course in Mathematics, the course in Physics, and the course in Mechanics must precede this course.

DRAWING

PROFESSOR KIDWELL AND MR. MOORE.

In planning the course in Drawing given in this school, the object kept constantly in view was to give special prominence to such branches of the subject as are of most value to the engineer; hence perspective, shades and shadows, etc., have been excluded, and more than the usual proportion of time is devoted to Mechanical Topographical Drawing.

Drawings that are not satisfactory are returned, and at the option of instructor, must be made up outside of the regular class hours.

The following schedule shows the distribution of work during the successive years:

FIRST YEAR.—Fall term, twelve hours a week.

DESCRIPTION, PREPARATION AND TESTING OF DRAWING INSTRUMENTS AND MATERIALS: graphical solution of geometrical problems. Descriptive Geometry. Projections on right and oblique planes; intersections of lines, surfaces and solids; plans, elevations and sections. Soennecken's system of Round Writing.

Angel's "Practical Plane and Solid Geometry" is used as the text book in Descriptive Geometry, and the other subjects are taught by lectures in conjunction with the practical work in the draughting room.

Every attempt is made to prevent mere copying. Accuracy, neatness, and a thorough understanding of the work in progress are insisted upon at all times, and no sheet will be accepted that would not pass in the average drafting room. The subject of lettering receives considerable attention during the entire course, as nothing more effectually spoils a good drawing or map than injudiciously selected or poorly executed lettering.

No student having conditions in Plane, Solid, or Spherical Geometry may take this term's work in Drawing.

WINTER TERM, ten hours a week.

TOPOGRAPHICAL DRAWING: Making scales, methods of plotting surveys, by protractor and rectangular co-ordinates; topographical signs. This branch of Drawing is under the personal supervision of the Professor of Civil and Mining Engineering, and is arranged with special reference to the practical work in *Plane and Mine Surveying*. The first sheets are devoted to the making of scales, and to the different methods of plotting survey lines, the student having previously made the necessary computations from field notes furnished him. These sheets are followed by practice in making topographical signs and in filling in the details of a survey. This course gives the student sufficient skill to plot his own surveys, and assists him in the making of these surveys, by teaching him what data are necessary for plotting.

SECOND YEAR.—Fall and winter terms, four hours a week.

DESCRIPTIVE GEOMETRY: Continuation of work of preceding year, until subject is completed. After principles given in text-book have been mastered, special problems prepared by instructor are given for solution.

LETTERING: Roman, Italic, Gothic, block and free hand lettering. Tinting.

ISOMETRIC AND CABINET PROJECTION: Construction drawing, dimensioning, lettering, and the shading of working drawings; conventional methods of hatching and tinting sections, tracing, blue printing, and use of bond paper; production of complete working drawings of separate pieces from the model, or rough sketches furnished by the instructor. Lectures, and work in Drawing Room.

Free-hand Sketching: Making working sketches, with all necessary views, sections, dimensions, etc., of pieces of machinery or timber constructions assigned by the instructor. This work must be done by the student outside of the class hours, in a book of sectioned paper to be devoted exclusively to this subject, and turned in for inspection on the date set by the instructor.

Students having conditions in the Fall term of the first year in Drawing cannot take this course.

Third Year.—Winter term, four hours a week.

Construction Drawing and Free-hand Sketching: Continuation of work of preceding term. Production of complete assembled drawings of machines in laboratory and work shops.

No student may take this course who has conditions in the preceding courses in Drawing, or in Shop Practice.

Third Year.—Winter term, three hours a week.

Graphical Statics: Analysis of roof and the simple forms of bridge trusses of various designs (Greene's "*Roof Trusses*", supplemented with lectures). This subject will be given under the direction of the Professor of Civil and Mining Engineering.

While the text book will serve as a guide, the scope of the instruction will not be confined to it. The course is designed to teach the theory of the graphical analysis of stresses in structures, and leads up to the course in designing given in the succeeding year.

No student may take this course who has conditions in any part of the previous courses in Drawing or Analytical Mechanics.

Fourth Year.—Fall term, nine hours a week.

Designing: Lectures and work in Drawing Room.

Prominence is given in this course to the designing of girders, columns, shafts, floors for heavy loads, framing, trestles, etc. Special attention is also given to designs for long lines of steam pipe, line and counter shafting for various duties, etc. No design is accepted unless accompanied by complete working drawings and bill of materials.

No student may take this course who has conditions in any part of the previous work in Drawing, Analytical Mechanics, Properties of Materials, Graphical Statics, Mechanism, Mechanics of Materials, or Steam Engineering.

The Three Years Course for Degree of Mining Engineer.

The schedule of studies for the three years course taken by students who entered previous to the Fall of 1893, will not be followed in the future, except by the classes to graduate in 1894 and 1895. A detailed statement of this course can be found in the catalogue for 1891-92. The following condensed schedule shows such parts of this course as will be given during the year 1894-1895:

SECOND YEAR.—Fall term, six hours a week: winter term, four hours a week. Lectures, and work in draughting room.

CONSTRUCTION DRAWING: Dimensioning, lettering, shading and tinting working drawings: tracing and blue printing. Isometric and Cabinet Projections. Freehand sketching from the model.

THIRD YEAR.—Fall term, four hours a week.

GRAPHICAL STATICS: Of Roof and Bridge trusses (*Green's Roof Trusses*).

THIRD YEAR.—Winter term, four hours a week.

Designing of girders, columns, shafts, floors, framing miscellaneous constructions in wood and metal. Lectures, and work in draughting room.

In addition to the regular instruction in Drawing, numerous applications of the subject are obtained in connection with the other courses; the students are required to make plats of all their field work in *Plane Surveying*, to prepare working plans and sections of a mine from their own survey, make a map and profile of a railroad surveyed by themselves, and to draw sections, diagrams, maps, etc., in their geological field work.

Much personal instruction is given during the entire course. In addition to the regular lectures and recitations, the instructors are present in the Drawing Room during the hours prescribed for practical work, to give advice and personal instruction to those who need it.

Whenever students desire the privilege of working in the Drawing Room on Saturdays or other holidays, during the fall and winter terms, arrangements may usually be made with the instructor, the day before, by which such privilege can be granted.

Special Students in Drawing.

Those who desire to enter as special students to take the course in Drawing only, or in Drawing in conjunction with some other subject, may do so, provided the professor in charge of the course is convinced of their competency to profit by the instruction. To pursue the course in Drawing with success, *Plane, Solid and Spherical Geometry* of two dimensions should have been well mastered. In case these subjects have not been completed, the professor in charge will prescribe as a necessary part of the student's work, the courses in mathematics which should precede the work in Drawing.

Equipment.

This Department is well equipped for every branch of the work it professes to teach. The more expensive or rarely used instruments are in stock, and are used by the students as occasion may demand. The drawing tables have been so planned that each student has a private drawer or locker for his instruments and materials and a rack for his drawing board. A printing frame capable of making a blue print 3x4 feet, several frames of smaller capacity, a slate vat for developing prints, and a drying rack, having been recently added to the equipment.

New Draughting Room.

In the new building now in course of erection for the Department of Mechanical and Mining Engineering, provision has been made for a draughting room 25x97 feet, with an annex 28x34 feet to contain instructor's office, dark room, blue printing outfit, etc. This room will be ready for use by September, 1894, and will provide accommodations for a largely increased attendance, and enable more efficient work to be done than is possible in the present quarters.

Instruments Needed by Students.

Each student, upon entrance, will provide himself with the following instruments and materials, a list of which is given for those who may desire to purchase before coming to Houghton:

One 5-inch Alteneder improved right line pen.

One 5½ inch Alteneder dividers (pivot joint) with hair spring, pen, pencil points, and extension bar.

One 2½-inch Alteneder bow pen.

One 2½-inch bow pencil.

One 2½-inch bow dividers.

One 8-inch horn protractor.

One 12-inch triangular scale, divided into twelfths.

One T-square, 36-inch blade.

One 8-inch 30 x60 rubber triangle.

One 8-inch 45 rubber triangle.

One each K. & E. curves, Nos. 1820-6; 1820-11; 1820-15.

One dozen German silver thumb tacks, ⅜ diam.

One bottle W. and N. or Higgins's prepared India ink.

One Faber's pencil form wood-cased rubber.

One rubber stamp.

One piece Artist's gum, ½x½x3 inches.

Two each Faber's artist's 6H and 4H pencils.

One bottle mucilage (or paste) with brush.

One medium sized sponge, fine quality.

One Arkansas stone, about ½x¾x3 inches.

Two cabinet saucers, about 1¾ inches diameter.

One piece chamois skin, not less than 12 inches square.

One Soennecken Round Writing Copy Book, and box of selected pens.

A black enameled tin box, 13x8x4 inches, with lock, in which instruments can be kept, is strongly recommended.

A drawing board and two sable brushes will also be required. *Owing to liability of getting sizes that will not answer, these latter should be purchased in Houghton.*

The articles called for in this list are necessary for a proper prosecution of the course, and care should therefore be taken to get the exact instruments specified, or others of *equal grade. Instruments not up to standard will not be allowed in the Drawing Room*, as they will not give satisfaction, and will waste the time of both instructors and students.

CHEMISTRY.

GENERAL CHEMISTRY.

PROFESSOR KOENIG, MR.———— AND MR. SEELEY.

First Year.—Fall term, eight hours a week for eight weeks, and five hours a week for six weeks. Winter term, seven hours a week. Summer term, twenty hours a week for six weeks.

This course in general chemistry is planned from the standpoint that all engineering resolves itself ultimately into a change of matter, either in form or in substance. More especially is this the case with metallurgical engineering. Not only a knowledge and habit of experimentation, but also a love and enthusiasm for it, are to be acquired by the student. It is thought that theoretical considerations should not form the basis of such a course. The system adopted may be called the historical system. The student does not start with a table of elements and atomic weights, nor thermo-chemical notions, nor the periodic harmony of the elements. He begins with the commonest bodies, to the handling of which he has been accustomed from childhood, although he may have never had a thought or query arising in his mind, concerning them. No re agents are used in the usual meaning of this term; heat is the only force used, charcoal and water the agents. In the course of his work the student discovers everything himself, and is made to draw his conclusions from every observation he records. It has been found possible to so arrange the series of experiments that no term or symbol need be used before the student can fully understand its meaning. At the end of the course, six lectures give a recapitulation of the main observations, and evolve out of them the present notions concerning the chemical nature of matter, and the systems of notation. In regard to apparatus, the greatest simplicity is observed, so that the students may make it themselves, even for elaborate experiments. The lectures are intended to show how to experiment; and experiments for effect are avoided. Everything must be for a purpose, nothing for mere show.

The guiding thread followed in the work is the professor's full notes, issued to the students in mimeograph copies. It is not found advisable to use any book of reference, because all those that are worthy of recommendation follow a very different plan to the one outlined above, and

and thus confusion must result. At the end of the course, however, the students will be in a condition to take up and read understandingly any book on chemistry.

Following is a synopsis of the course:

Fall Term.

(1). The metals: iron, copper, lead, tin, and their behaviour when heated; discovery of oxydation and the composition of the air; oxygen-azote. Action of water on the metals at red heat; discovery of hydrogen. The weights of azote and hydrogen compared. The notion of mass-units or atomic weights. Electrolytic decomposition of water. Atomic weight of oxygen, and chemical symbols or formulæ.

(2). The behavior of copperas when heated; discovery of a powerful agent, the oil of vitriol, which the students distill. The connection between this substance and sulphur is traced.

(3). Experiments with common salt and Varec salt. Discovery of the spirits of salt, of chlorine, and of chlorides generally; also bromides and iodides.

(4). Potash and soda ash. Discovery of potassium and sodium. The students are made to distill these metals from the ash and charcoal.

(5). Nitre and Chili nitre. Discovery of the oxides of nitrogen, of nitrogen itself, of its identity with azote, and of ammonium and its compounds.

Winter Term.

(6). Limestone. Discovery of carbon in the limestone gas, by its action on sodium. Identity of this body with charcoal, mineral coal. Gas analysis, distillation of wood and coal, of petroleum. The nature of fats (animal and vegetal). Alcohol, ether, albuminoid bodies. Discovery of cyanogen.

(7). Study of sulphur and combinations.
(8). Bone ash; the discovery of Phosphorus.
(9). Discovery of Fluorine.
(10). Borax and quartz, Boron, Silicon.

Summer Term.

As all the principal agents and reagents have now been found by the student, and prepared by him, it is not very material in what sequence the combinations of the metals are treated. The larger part of the time is occupied by a course in Blowpipe analysis, which is so united with reactions in the humid way, that it forms a limited course in Qualitative analysis.

The Professor's notes are the guide in this work. Students recite two hours a week during all three terms.

QUALITATIVE ANALYSIS.

PROFESSOR KOENIG, MR.——— ——— AND MR. SEELEY.

SECOND YEAR. Fall term, eight hours a week; winter term, eight hours a week, seven weeks.

This course is an amplification of the *Blowpipe Course*, in the direction of humid reactions, more particularly in small quantities of an element, when admixed with a large excess of other elements or combinations. A. Elliot's textbook of qualitative analysis is followed. The spectroscope is used in all cases where it promises to be serviceable. The students recite on their work, on the reaction of elements generally. They are drilled in the writing and balancing of chemical equations. The class will generally have acquired proficiency enough to pass an examination in the middle of the winter term. They are then promoted to the quantitative laboratory. Those not proficient in equation writing and in recitation work, must take the course over. Those behind only in the solving of unknowns, can be permitted to attend the lectures on quantitative methods.

QUANTITATIVE ANALYSIS.

PROFESSOR KOENIG, MR.———— AND MR. SEELEY.

SECOND YEAR.—Winter term, eight hours a week, seven weeks.

THIRD YEAR.—Fall term, ten hours a week; summer term, forty-five hours a week for seven weeks.

Lectures two hours a week. Recitation one hour or two hours. Professor Koenig's Notes. For reference and amplification are recommended: Fresenius's "Qualitative Analysis", Am. Edit.; Edgar F. Smith's Electro-chemical Analysis; Fresenius's Zeitschrift; American Journal of Analytical Chemistry; etc.

For the purpose of introducing the student at once to all operations of analysis, and more especially that he may form his judgment as regards rapidity of work and accuracy, the students prepare chemically pure, crystallized copper sulphate, and determine the copper by gravimetry (as $Cu_2 S$ after Rose); by electrolysis; by titration with K Cy; by colorimetry in the ordinary way, and spectroscopically after Vierordt.

(2). Analysis of an iron ore containing Fe, Mn, Al, Ti, Si, P, S, Ca, Mg.

(3). Analysis of Pig iron containing Fe, Mn, C, P, S, Si.

(4). Analysis of steel containing Fe, Mn, C, P, S, Si, W.

(5). Analysis of an ore, containing As, Sb, Sn, Ag, Cu, Bi, Pb, Fe, Zn, S; also analysis of quartz and fluorite.

(6. Titration of silver, lead and zinc.

In the recitation work the principal drill consists in making the students apply to special cases those methods which they have acquired in working on the complicated mixtures, as time will not allow them to make all the separations. Accuracy is aimed at first, rapidity second.

SYNTHETIC CHEMISTRY.

PROFESSOR KOENIG.

FOURTH YEAR.—Winter term, 23 hours a week (elective). The principal aim of the fourth year course is to direct the student how to go to work in a new field of chemical research, whether theoretical, analytical, or practical. There is no end to this kind of work, but if left to chance and untrained exertion, its cultivation is not apt to be remunerative. On the other hand, if a man has been trained under experienced direction his efforts have all chances in favor of success. It is not possible to outline a course of this kind, since each specialty is more or less independent. But some idea may be derived from the following.

First, the idea. The student may have the idea himself, either from attentive reading of the technical periodicals, from a lecture, or from observation in a mill or factory. In the majority of cases it will be a suggestion of the professor's. Now, after discussing the probable or possible scope of the investigation, the student must master all the available literature in journals, proceedings of associations, patent reports, encyclopaedias, etc. When this is collected it will be possible to pronounce on the chances of success or failure in reaching the desired end. The student will be led to see where and why others have failed, consequently where the new experiments will have to be started from; and accordingly he sets at work or goes over to another idea. The results obtained will form the subject of the thesis of each student electing this course.

Instead of lecturing, the professor will hold a seminar of two hours each week. For each week a student will be assigned to the preparation of a report or synopsis of some technical subject. After the reading of the report, the professor will discuss it, and may be interrupted by the students for questions, as in a general debating assembly.

Such special students as prefer to perfect themselves in the technical use of certain methods of analysis, rather than to investigate new fields and new methods, have permission to follow their choice, and will have all advantages which the professor's experience may afford.

The laboratories and store-rooms of the school are sufficiently provided with apparatus to prosecute studies of the above character.

ASSAYING.

PROFESSOR KOENIG. MR. .... AND MR. SEELEY.

SECOND YEAR.—Summer term; forty-five hours a week, one week.

THIRD YEAR.—Summer term; forty-five hours a week, two weeks.

Instruction is given in the fire assay of gold, silver, lead and copper ores, gold and silver coin, bullion, copper "mineral", and slags.

The assay laboratory contains ten large crucible furnaces and eighteen muffle furnaces of the Brown pattern, and sixteen crucible and muffle gasoline furnaces (Hoskins's), the intention being to provide a muffle for each student, and so avoid the inconvenience of making one furnace do for two or more persons. The laboratory is provided with a Blake and a Gates crusher, laboratory size, to be run by power; large buck plates, large and small mortars, sets of sieves, etc. The weighing room is supplied with six pulp scales and five button balances, of Troemner's and Becker's make, for use in this department.

Of the three weeks devoted to assaying, almost all the time is spent in the laboratory; lectures and recitations form a minor portion of the work. One hundred and twenty-five to one hundred and fifty assays are made, upon samples differing as widely as possible in composition, and consequently, in methods of treatment.

METALLURGY.

PROFESSOR KOENIG.

THIRD AND FOURTH YEARS.—Third year: Fall term, five hours a week; winter term, three hours a week. Fourth year: Fall term, five hours a week.

Instruction in Metallurgy is given, during the third and fourth years, in lectures and recitations, supplemented when possible by the use of text-books and visits to the metallurgical works. The object of the course is to give the student a through foundation in the fundamental principles of the different metallurgical processes. In studying each of the metals, special attention is paid to the properties of the commercial forms, and to the effects of impurities upon their value for engineering purposes. During the third year, fuel, refractory materials, iron, steel and aluminum are discussed; the various ores of iron; the properties of cast iron, wrought iron and steel; the methods by which objectionable elements in the ore may be kept out of the finished product, or their effects neutralized; theory and description of blast furnace and puddling process; puddled, blistered, and crucible steel; acid and basic Bessemer steel; and open-hearth steel processes.

During the fourth year the metallurgy of copper, lead, silver and gold is studied by lectures and frequent references to the library. It is the aim of these courses to acquaint the student with the best modern American methods in sufficient detail to enable him to make an intelligent choice for the treatment of any particular ore, and also to familiarize him with the modern metallurgical literature.

In connection with these courses frequent visits are made to the smelting works in the vicinity, and each student is required to report upon the observations made by him.

Students taking either of the courses in Metallurgy must have taken the first year's course in Chemistry and the second year's course in Mineralogy.

METALLURGICAL DESIGNING.

PROFESSOR KOENIG.

This course is divided into two parts:

First Part.—The student is directed to analyze sectional drawings of furnaces, in regard to number, shape and dimensions of parts, to calculate or estimate the dimensions required for a given daily production and to make working drawings for the parts.

Second Part.—Designing of a complete plant for the reduction of a given ore. Estimation of the required power, arrangement of the machinery, economy of space, placing of the apparatus in such manner that the successive operations require a minimum of handling. Estimated cost of the plant.

METALLURGICAL EXPERIMENTATION.

PROFESSOR KOENIG.

This course is essentially a part of the course in Synthetic Chemistry, except in so far as it deals with well established methods chiefly, and finds its originality in adapting such methods to peculiar ore combinations, or metal combinations.

The special subjects, among which the student may choose, are:

(1). Gold ores to be treated either by amalgamation, by the cyanide process, by chlorination, or by smelting, in order to insure complete extraction.

(2). Silver ores similar to gold ores.

(3). Electrolysis of ores or secondary products, either in aqueous or igneous liquefaction.

(4). Studying the influence of small quantities of negative elements upon the physical properties of metals and the metallic alloys.

(5). Microscopic study of metals.

MECHANICAL ENGINEERING.

PROFESSOR KIDWELL AND MR. MOORE.

The instruction in Mechanical Engineering has been made sufficiently full to give the student proper preparation for actual work, and to point out the studies subsequently to be pursued, should he desire, to continue the subject after graduation. Following is a detailed statement of the course:

SECOND YEAR.—Fall term, two hours a week.

PROPERTIES OF MATERIALS OF ENGINEERING.—General qualities of metals; cast and wrought iron; steel; copper, brass and bronzes; lime, concrete and brick; paints, etc.; timber; and cordage. *South Kensington Notes on Building Construction, Vol. III.*

The course includes a discussion of methods of manufacture of the more important materials (except such information as comes within the province of the course in Metallurgy), forms in which they appear in the market, their adaptation to the purposes of the engineer, methods of preserving materials from corrosion and decay, etc. The course is supplemented with practical work in testing, for details of which see section on *Mechanics of Materials.*

No student may take this course who has conditions in Physics.

THIRD YEAR.—Fall term, three hours a week.

MECHANISM.—Laws of motion; linkwork; cams; teeth of wheels, with use of odontograph; wheels in trains; aggregate motion; miscellaneous problems in Applied Mechanics, with applications. Power-transmitting machinery, pulleys, belting, hangers, shafting, clutches, etc., and determination of proper sizes for particular duties. Taught partly from lectures, partly from Goodeve's *Elements of Mechanism* as a text-book.

No student may take this course who has conditions in Mathematics, Analytical Mechanics, or Mechanical Drawing.

THIRD YEAR.—Winter term, four hours a week.

STEAM ENGINEERING.—Description and discussion of the various details of engines: mechanics of the steam engine, and determination of proper proportions for its most important parts. Taught partly by lectures, and partly from Holmes' "*The Steam* [illegible]

No student may take this course who has conditions in Mathematics, Mechanism, Properties of Materials, or Shop Practice.

Fourth Year.—Fall term, three hours a week for six weeks; two hours a week for eight weeks.

Steam Engineering.—An elementary course in thermodynamics, and its application to steam and air engines, rock drills, etc.; the steam engine indicator; interpretation and methods of working up indicator diagrams; injectors, ejectors; surface, jet and ejector condensers; jacketing; distribution of steam in compound cylinders. Holmes' *The Steam Engine*, supplemented with lectures.

Fall term, two hours a week for six weeks, three hours a week for eight weeks.

Valves and Valve Gears. Kinematics of the plane slide valve, link motions, double valve gears, radial and drop cut-off gears. Peabody's *Valve Gears for Steam Engines*.

These courses are not open to any student having conditions in the preceding work in Steam Engineering or Mechanical Drawing.

Winter term, two hours a week.

Steam Engineering. Boilers. General description of the various kinds of modern boilers. Determination of proper proportions for heating surface, grate surface, flues, etc. Boiler appurtenances, settings, proportions for boiler chimneys. Care and management of boilers, boiler testing. Heating value of fuels. Wilson's *Treatise on Steam Boilers*.

Winter term, two hours a week.

Steam Engineering. Pumps and pumping machinery. Discussion of typical forms of pumps, and their adaptation to various duties. Methods of testing pumps.

Winter term, one hour a week.

ENGINEERING APPLIANCES.—Steam gauges; lubricators; safety valves; reducing valves; steam traps; feed heaters and purifiers; steam separators; damper regulators; the various styles of patent grates; steam pipe and fittings; boiler and pipe coverings; rubber, leather and cotton belting, etc. Instruments and appliances used in engine and boiler testing, such as dynamometers, planimeters, speed counters, pyrometers, calorimeters, etc. Taught partly by lectures, and partly from the various manufacturers' trade circulars.

None of these courses are open to any student having conditions in the preceding term's work in Steam Engineering, or Mechanical Drawing.

Summer term, forty-five hours a week for four weeks.

PRACTICAL WORK IN TESTING LABORATORY.—Use of steam engine indicator, Prony brake, and other dynamometers, testing of engines and boilers, gauges, steam pumps, etc.

This course is not open to any student having conditions in Physics, Mechanics of Materials, or the preceding term's work in Steam Engineering.

MECHANICS OF MATERIALS.

PROFESSOR KIDWELL.

THIRD YEAR.—Fall term, three hours a week.

APPLICATION OF THE PRINCIPLES OF STATICS TO RIGID BODIES: elasticity and resistance of materials; cantilevers; simple, restrained and continuous beams; bodies of uniform strength; riveting; torsion of shafts; combined stresses; computation of proper sizes and proportions of beams, columns, and shafts. (Merriman's *Mechanics of Materials*, supplemented with lectures.)

No student may take this subject who has conditions in Analytical Mechanics, Mathematics, or Properties of Materials.

THIRD YEAR.—Summer term, forty-five hours a week for three weeks.

TESTING OF MATERIALS OF ENGINEERING.—Such as wrought and cast iron, steel, brick, cement, stone and slate. Each student makes a series of tests in tension, compression, torsion, shearing, and cross breaking, on laboratory testing machines.

SHOP PRACTICE.

PROFESSOR KIDWELL, MR. SHIELDS AND MR. PURFIELD.

SECOND YEAR. Summer term, five days a week for ten weeks.

The entire summer term of the second year of the course is devoted to shop work. In the Machine Shop, instruction is given in chipping, filing, scraping, general vise work, pipe fitting, and use of machine tools. In the Pattern Shop, a course in bench work, making joints, turning, etc., precedes actual practice in pattern making. To familiarize the student with the use of actual working drawings, nearly all work done in both shops is to blue prints made in the Drawing Room. In order that the students may learn actual shop methods, as used at the present day, the instructors who assist the professor in charge will be men who have had a number of years' practical experience in the kind of work they are expected to teach here.

The shop work is planned with reference to the needs of the School as well as of the students; and models of valves, link motions, mechanical movements, etc., for lecture purposes, pedestals, hangers, and part of the smaller machine tools needed in the shops, will be made by the students.

The equipment of the shops has been carefully selected. The Machine Shop as now planned contains work benches for twelve students, a 24-inch by 16-foot New Haven Tool Co. engine lathe, a 12-inch by 5-foot Prentice engine lathe, two hand lathes, a 34-inch automatic feed Blaisdell drill press, a 20-inch Lodge and Davis drill press, a 16-inch Gould and Eberhardt shaper, a Whitcomb planer, of capacity 8x2x2 feet, a Brainard No. 4 Universal milling machine, one wet and two dry emery grinders, and several smaller machine tools.

A 20″x20″x4 foot Seller's planer, a 14″x6 foot Lodge and Davis engine lathe, with power cross-feed, a 13″x5 foot Putnam engine lathe, and a 10″ Boynton & Plummer traverse shaper, have also been ordered, and will be available for use during the summer term of 1894.

The assortment of chucks, taps, drills, reamers and general tools is very complete. For practice in pipe fitting a separate bench has been provided, and a complete set of pipe tools and fittings up to two inches inclusive is in stock. The present Pattern Shop contains two Clement wood lathes, a 33-inch Fay band saw, Beach jig saw, emery wheels and grindstones, Pedrick and Ayer gouge grinder, a very complete assortment of hand tools and appliances, and work benches for eighteen students. Each student, in each shop, has a separate work bench, locker and set of hand tools, for which he will be held responsible. Any damage to tools, or other part of the equipment, beyond wear and tear by legitimate use, will be charged to the student accountable for it.

The check system of accounting for tools is used in both shops, thus familiarizing the student with its operation by actual practice. Both shops are lighted with electricity furnished by a No. 4 Edison dynamo in the testing room. Power for shops is supplied by a 9x9-inch New York Safety vertical high speed engine, arranged to take steam either from the boilers in the building, or from the boiler in the Stamp Mill.

To familiarize the student with the operation and care of machinery, each one will be detailed from time to time to fire the boiler, run the engine, clean and oil the machinery, and to perform such other duties as the instructor in charge may assign him.

No students having conditions in Drawing, Elementary Mechanics, or Properties of Materials, may take this course, except those who enter for shop work only.

Special Students in Shop Work.

Those who desire to take shop work only, and devote all their time to it, may be admitted as special students on presentation of evidence that they can pursue the course with profit. Such special students must be of the age prescribed for entrance, and should have the equivalent of a high school course. Application should be made to the Professor in charge of the work not later than one week before the course opens in the summer term. *Such special students will be subject to all the usual rules of discipline in this school, and must be regular in their attendance or they will be dropped from the course.*

No student will be allowed to enter the course after the first week of the summer term.

THE THREE YEARS COURSE FOR THE DEGREE OF MINING ENGINEER.

The classes to graduate in 1895, will follow the regular three years' course laid down for all students who entered previous to the fall of 1893. The following is an outline of the work they will follow in this department in 1894-95.

SECOND YEAR.—Winter Term, two hours a week.

PROPERTIES OF MATERIALS:—*South Kensington Notes on Building Construction, Vol. III.*

Winter Term three hours a week.

MECHANISM:—Goodeve's *Elements of Mechanism.*

THIRD YEAR.—Fall Term, five hours a week; Winter Term four hours a week.

STEAM ENGINES AND BOILERS:—Holmes' *The Steam Engine*, supplemented with lectures.

Winter Term, one hour a week.

ENGINEERING APPLIANCES:—Taught by lectures.

Fall Term, three hours a week.

MECHANICS OF MATERIALS:—Merriman's Mechanics of Materials, supplemented with lectures.

Equipment.

The Mining School is well provided with instruments and machinery necessary for practical demonstration of the subjects taught in the class room. There are now in stock, one Tabor indicator, one Crosby indicator, one Hine and Robertson indicator, eight polar planimeters, three varieties of steam calorimeters, ten of Greene's standard thermometers for calorimetric work, Heath stop watch, Tabor speed counter, Schaeffer and Budenburg tachometer, lazy tongs, Hine and Robertson reducing motion, two draught gauges, Ashcroft boiler test pump and gauge, gauges for use with water or steam, one Shaw's standard mercurial column gauge tester, Ashcroft pyrometer, Bristol recording gauge, a number of working injectors with cut models of same, etc. For indicator practice, there are now available the 9x9 New York Safety engine in the shops, an 8x12 Buckeye engine in Stamp Mill,and a 5x5 high speed engine to be used for driving the testing machines.

The School is provided with a 100,000 lb. machine fitted for tests in tension, compression, cross-breaking and shearing, a Thurston autographic torsion machine, an Olsen 2,000 lb. cement tester, appliances for testing the shearing strength of wood, and an Ashcroft oil testing machine. There are also on hand a Henning electric-contact micrometer for measurement of extension, an Olsen electric contact compression micrometer; a deflectometer, a Brown and Sharp Vernier caliper, and several screw micrometers.

Those having materials to be tested should make application to the professor in charge of the department, and make definite arrangements with him for the precise work they desire to have done.

New Building and Equipment.

Owing to the increasing attendance, and the extension of the work of this department, due to the adoption of the Four Years Course, it has become necessary to make a material increase in the equipment, and provide larger and better planned laboratories than those now in use in the main building. To meet this need there is now nearly completed a new building, in which provision has been made for ample laboratory space. The additional instruments and machinery necessary for proper equipment of the new laboratory will be added at once.

The machine and Pattern Shops, temporarily located in the main building, will, after August 17th, 1894, be removed to the new building, which is especially designed for shop and laboratory purposes. This building will contain the following-named rooms:

BASEMENT.

Machine Shop	97x24 feet.
Engine Room	34x17 feet.
Electrical Laboratory	34x27 feet.
Lavatory	28x10 feet.

FIRST FLOOR.

Pattern Shop	97x25 feet.
Lecture Room	28x26 feet.
Professor's Office	18x 9 feet.
Tool Room	11x 8 feet.
Lavatory	12x12 feet.
Paint Shop	16x13 feet.
Model Room	18x 9 feet.
Storage Battery Room	15x11 feet.

SECOND FLOOR.

Drawing Room	97x25 feet.
Blue Print Room	12x 8 feet.
Lecture Room	35x28 feet.
Assistant's Office	12x11 feet.
Office of Mining Department	16x15 feet.
Map Room	15x12 feet.
Lavatory	11x11 feet.

An annex contains a Fuel Room 16x34 feet, and a Boiler Room 29x34 feet. In the latter will be located three boilers, two of which are to be used for heating purposes. To enable the student to become practically familiar with water tube boilers, a 58 HP Stirling water tube boiler will be used to supply steam to shop and laboratory engines.

As soon as the building is ready for occupation, a material increase in both shop and laboratory equipment will be made. The number of machines, hand tools and appliances, work benches, testing apparatus, etc., will be increased sufficiently to provide accommodations for from seventy to eighty students at work at one time. Both engines now in use will be retained, and to them will be added a new 8″x24″ Corliss engine fitted with surface condenser, and all attachments needed for complete engine tests.

Owing to the danger and inconvenience of gas in the shops, it has been decided to light the whole building with electricity.

ELECTRICAL ENGINEERING.

PROFESSOR KIDWELL.

The use of electricity in mining, both as an illuminant, and as a motive power for hauling, pumping, and operating portable machinery, requires of the mining engineer a working knowledge of Electrical Engineering; hence an elementary course in that subject is prescribed for all regular students in this institution.

The instruction is made as comprehensive as the time available will permit, and special care is taken to familiarize the student with the fundamental principles of the science. Sufficient ground is covered to enable him to understand the electrical machinery, appliances, and processes in general use, and give him a good foundation for more advanced work, should he desire to devote himself more particularly to Electrical Engineering after graduation.

The preparatory instruction in Electricity given in Physics is supplemented with the following course:

THIRD YEAR.—Winter term, three hours a week.

FOURTH YEAR.—Fall term, three hours a week; winter term two hours a week (elective).

ELECTRICAL INSTRUMENTS AND MEASUREMENTS: Primary batteries, the various forms of ammeters, voltmeters, bridges, resistance sets, etc., and the method of using them in making measurements of current, electro motive force, insulation resistance, and in determining faults, etc. Power and measurement.

ELECTRICAL ENGINEERING: Theory of dynamo, both direct and alternating current, with description and discussion of the typical forms in general use; motors and their applications; transformers; stage batteries; wiring; fittings; etc. (Slingo and Brooker's *Electrical Engineering*, and Badt's *Incandescent Wiring Handbook*.

Summer term, forty-five hours a week for two weeks.

PRACTICAL WORK IN ELECTRICAL LABORATORY: Measurements of current, electro motive force, resistance, calibration of instruments, etc., determination of efficiency of dynamos and motors. Practice in running dynamos for arc and incandescent lighting.

This course is not open to any student having conditions in Mathematics, Physics, Analytical Mechanics, Mechanical Drawing, or Steam Engineering.

Equipment.

In the new Engineering building now erected an *Electrical Laboratory* has been provided for, and it will be thoroughly equipped with the machinery and apparatus necessary to give the student a practical acquaintance with electrical light and power work. The equipment will include incandescent dynamos, both direct and alternating current, and an arc light machine, with complete switch boards, current and pressure indicators, regulators, transformers, etc. While the laboratory is running the current neccessary for lighting the building will be supplied from the dynamo room.

The dynamos will be driven by a separate high speed automatic engine.

The instruments necessary for electrical testing will also be provided, as well as a battery of not less than twenty-five storage cells, to furnish current for measurements, lecture demonstrations, and electric projecting lantern.

Until this laboratory can be fitted up, the instruction will be given mainly by lectures; but in connection with the shop course some practical work in dynamo running will be given. A 12 K Edison dynamo has been fitted up complete, with switch board, regulator, etc., and is wired to light the shops and mechanical laboratory. There are also a 2 HP Sprague motor, arranged to drive some of the testing machinery, several Ayrton and Perry ammeters and voltmeters, Edison ammeter, storage cells, and other instruments for electrical work.

PLANE SURVEYING.

PROFESSOR ———.

First Year.—Fall term, three hours for six weeks; Winter term, three hours a week.

The course in surveying is designed to be practical and complete as far as regards the ordinary wants of a mining or civil engineer. The course begins in the winter term of the first year. This part of the course is devoted exclusively to the study of the computations necessary in plane surveying, and to the making of maps and scales.

Johnson's *Theory and Practice of Surveying* is used as a text-book. The Topographical Drawing, which is in charge of the same instructor, is arranged with special reference to this course, and the two subjects are made to harmonize, and to prepare the student to perform the practical work of the summer course in surveying with facility.

Understanding the computations and the methods of plotting, the student is able to appreciate the different methods of collecting data, and can devote his whole attention to them and to the practical work. *To take this course the regular student must have passed in all the preceding Mathematics.*

FIELD WORK IN SURVEYING.

MR. ABBOTT AND MR. DAVIS.

FIRST YEAR.—Summer term, forty-five hours a week for eleven weeks.

During eleven weeks of each summer a special course of surveying will be conducted. Attendance upon this course is obligatory for all regular students who intend to complete the first year. The object of this summer course is two fold:

First, to give the regular students more thorough and extended practice in the field than it is possible to do when they are attending to other school work. Second, to provide a thorough, practical course in surveying for persons, other than regular students, who may be desirous of becoming surveyors, or who may wish to obtain practica experience in the subject. There is perhaps no course o study which can be offered by an institution, that will give such quick and profitable returns for the money and time expended by the pupil, as a thorough, practical course in surveying, since employment at a fair salary can almost always be obtained by a competent surveyor.

In this summer course study and practical work are combined.

Johnson's *Theory and Practice of Surveying* (last edition) is used as a text-book, being supplemented when necessary with lectures. Generally the first hour of the day is devoted to class-room work and the remainder of it to field work.

The subjects studied comprise the use and adjustment of surveying instruments, and methods of surveying.

For field work the students are generally divided into squads of two men each. Each squad is required to make a certain number of surveys, and each member of the squad has to make, from the work done, a full set of notes, computations and maps.

The field work consists of:

1. Exercises in pacing, with a detailed survey of a field by pacing.
2. Practice in chaining distances, and in laying off right angles and parallel lines with the chain.
3. Practice in ranging lines with sight poles under different conditions.
4. Exercises in reading compass bearings.
5. Detailed survey of a farm, made by means of solar compass and chain.
6. Adjustment of the hand level, and practice in its use.
7. Topographical survey on the rectangular plan, with compass, chain and hand level.
8. Adjustment of the transit, and exercises in reading the angles of a triangle by the repetition method.
9. Determination of the true meridian by observations

on Polaris and on the sun, and by means of solar attachments to the transit.

10. Running a close traverse, the angles being determined by repetition, the distances measured with a steel tape, and afterwards corrected for inclination, catenary, and temperature.

11. Running an azimuth traverse around a polygon, the distances being measured by stadia.

12. City surveying, laying out lots and streets, and determining the position of house and fence lines.

13. Adjustment of the Wye level, and running a line of levels about one mile in length.

14. Survey of a mining claim, with transit, according to government regulations.

15. Retracing and subdividing of a section of land in accordance with the United States Government field notes.

16. Topographical survey with the plane table, based upon a system of triangulation with the transit.

17. Topographical survey with transit and stadia.

15. Railroad survey. About one mile of road is located, slope stakes set, profiles, maps and cross sections made, and the cuttings and embankments calculated.

The equipment for instruction comprises the following set of instruments: One plane table from Buff and Berger; nine transits, three from Buff and Berger, three from Heller and Brightly, two from Fauth, one from Gurley; five Burt solar compasses; five magnetic compasses; six Wye levels, one from Buff and Berger, three from Heller and Brightly and two from Gurley; fifteen Locke hand levels. In addition to these more expensive instruments, the School own the necessary number of mining lamps, chains, steel tape poles, rods, etc.

Two of the transits are provided with three tripod ou fits for mine surveying, and all the transits are adapted to mine as well as surface work.

Persons who wish to join the Summer course only, are required to prepare themselves upon the first two books of Davies's Surveying revised by Van Amringe, in the subjects of Plane Trigonometry, Logarithms and Mensuration.

Those attending the Summer Course should provide themselves with Johnson's *Theory and Practice of Surveying* (last edition), a pair of six-inch dividers with pen and pencil attachments, a right line pen, a decimal scale, a large triangle, a T square, medium and hard pencils, and a twenty-five foot steel pocket tape graduated to feet and tenths. These articles are indispensable, but additional drawing instruments will be found convenient.

The furnishing of the surveying apparatus by the Mining School is a considerable expense to the institution, and while losses due to ordinary and legitimate wear and tear of the instruments are borne by the school, any injuries due to carelessness on the part of the student must be made good by him.

The summer course in surveying will commence each year about the first of June, and all persons who desire to attend are requested to send in their names early to the professor in charge of the course, or to the Director of the Mining School, in order that proper provision may be made for them. This course, like all others in the School, is free to any one who is properly qualified, whether a resident of the State of Michigan or not. The course is given in Houghton.

Regular students, in order to take this course, must have passed in all the preceding Mathematics and Plane Surveying.

MINE SURVEYING.

PROFESSOR ————.

Second Year.—Fall term, one hour a week for six weeks; Winter term, one hour a week; Summer term, forty-five hours a week for two weeks.

Instruction in Mine Surveying is given to the second year students by means of text-books, lectures and recitations. Many practical problems are assigned the students, to be solved by them.

The field survey conducted in the first year largely prepares the student for the mine surveying. The first two weeks of the spring term, preceding the four weeks given to practical mining, are spent in making a complete survey of some mine or portion of a mine. In the survey, lines are transferred underground, shaft lines are established, and courses are run in cross-cuts. Drifts, stopes, rooms and stations located, and cross and longitudinal sections made. Plans and elevations are made of the mine surveyed.

Regular students taking this field work must have passed in the preceding work in Mine Surveying and in the Plane Surveying.

MINING.

PROFESSOR ————.

Second Year. Fall term, three hours a week for six weeks; Winter term, three hours a week; Summer term, forty-five hours a week for four weeks.

Third Year.—Fall term, four hours a week for six weeks; Winter term, four hours a week.

FOURTH YEAR.—Winter term, nine hours a week (elective).

This course is given in lectures and text-book work, supplemented with drawings, photographs and the actual examination of mines, and extends through the second, third and fourth years.

In general, instruction is given in excavation, prospecting, mine development, underground operations, mine ventilation, mine lighting, mine surveying, designing shaft and rock houses, location of the various parts of a mine plant relative to one another and to the underground workings, mine accounts and mine management.

The entire working day for six weeks of the spring term of the second year is given to mine surveying and the study of mines and mining operations.

Instruction in Mining Engineering is given in the fourth year.

More in detail the course is as follows:

(1) EXCAVATIONS OF EARTH AND ROCK. Method of removing material; machines and tools used in loosening and handling material; explosives used in loosening rocks; and drainage of pit excavated.

(2) TUNNELLING. Excavating tunnels; timbering tunnels; removing of excavated material; ventilation and location of tunnel; examination and survey of mineral property and making reports on work done.

(3) QUARRYING. Formations quarried to advantage; methods used depend on geological formation; open quarrying; underground quarrying; explosives, charges; block splitting and dressing.

(4) PROSPECTING. Various methods. Importance of doing work well.

(5) MINE DEVELOPMENT. Location and sinking of shafts, test pits and winzes, and driving of cross-cuts, drafts and adits.

(6) DRILLING. Various operations in which drills are

used; machine drills for deep holes; machine drills for shallow holes; drilling in shafts, winzes, stopes and drifts, and placing holes under various conditions.

(7) BLASTING. Theory of blasting; conditions that will admit of blasting; explosives used in blasting; charging; detonators; methods of firing blasts; ventilation; removal of stuff.

(8) HAULAGE. Various conditions met with in haulage; loading tram cars; use of sledges, wheel barrows and carts, in getting material moved to tram-cars; tram cars, their form, size, shape, and material of construction; motive power for tram-cars, and the various ways in which it is applied; inclined planes, gradients, and level roads; junctions, stations, and curves.

(9) HOISTING. Power to be used; transmission of power by wire rope, compressed air, steam, water and electricity; conical and cylindrical drums and reels; ropes, girders, cages, kibbles, safety devices, and signalling.

(10) EXPLOSIVES. Nitro-glycerine; various explosives prepared with nitro-glycerine; other high explosives; fulminates; directions for using and methods of firing.

(11) DRAINAGE. Sources of water found in mines; keeping of water out of mines; natural drainage; drainage by means of mechanical devices and pumping machinery.

(12) VENTILATION. Causes of bad air in mines; natural ventilation; winter and summer currents; artificial ventilation; furnaces, blowing machines and fans; conditions to be observed in distribution of air currents and testing of foul air.

(13) LIGHTING. Candles, air lamps, coal gas, and electric lighting; distribution of lights; various safety devices used in lighting and expense of lighting.

(14) TIMBERING. Timbering in shafts, cross cuts, winzes, drafts and stopes; handling timber; kinds of timber used in mines; preservation of timber; cost of timber; saving of timber resulting from the use of caving and filling methods.

(15) HYDRAULIC MINING. Physical conditions; methods of placer mining; some of the properties of water; construction of dams; waterways and sluices.

(16) COAL MINING. Exploring for coal; tools used in coal mining; methods of working coal; ventilation of coal mines; timbering; haulage and the more important operations connected with coal mining.

(17) DEEP WELLS AND DEEP BORINGS. Where employed; various methods of making borings and making wells.

(18) AIR COMPRESSORS AND ROCK DRILLS. Mechanism of rock drills and compressors; testing efficiency of machines and comparison of various makes of machines.

(19) ACCIDENTS. Accidents from explosives and from falls of roof and sides; accidents from other causes; means of guarding against accidents; legislation regarding the preventing of accidents.

(20) SURFACE PLANTS. Consideration of various conditions to be met; surface equipment; location of power houses, boiler houses, rock houses, drys, shops, tramways and railroads.

(21) MINE ACCOUNTS. Books to be found in most mine offices; entering and balancing accounts; cost sheets; reports made to mine officials and stockholders. Each student taking this subject is given a set of books in which to enter and balance accounts. Costs and estimates of mine supplies are an important consideration in connection with mine accounts, as here given.

(22) MINE MANAGEMENT. Mine officials and their duties; some of the questions to be answered by the officials; place of business of mine officials; salaries and wages; work done by contract, and on company account; tribute working and its results.

WORK IN PRACTICAL MINING.

PROFESSOR ————————.

Practical Mining, as given in the course, comprehends the study of mine equipments and mining operations in and about the mines. Excursions are made under the instructor in mining, on Saturdays, during the fall and winter terms of the second year, to the copper mines in the vicinity of the Mining School. The student is early made acquainted with the general working of copper mines; which is a great advantage in the lecture room to persons not having previously some knowledge of mines and their operation.

During the spring term of the second year, the entire working day for four weeks is given to the study of iron mines. Half of this time may be put in at a large mine. The student is required to study in detail tools and machines, and drilling, blasting, haulage, hoisting and timbering operations. He makes sketches, which are turned over to the instructor at regular intervals to be examined. During the remaining two weeks the class goes from mine to mine, making a study of the variations from what was seen in the first iron mine visited. This plan is followed in the study of copper mines. Occasional trips are made to the mines during the third and fourth years, to examine special features bearing upon work in hand at the School.

MINING ENGINEERING DESIGNING.

PROFESSOR ——— ——— AND MR. MOORE.

FOURTH YEAR.—Winter term, nine hours a week.

In mining designing, the student designs in the drawing room, under the direction of an instructor, foundations, trestles, shaft and rock houses, and timber construction for underground service. Complete working drawings are made of the constructions designed.

BOTANY.

THE DIRECTOR.

Second Year.—Fall term, two hours a week for eight weeks.

Instruction in this subject is given by lectures, with recitations upon the same. It is intended in these lectures to give a brief review of botanical classification, the special characters of important plants economically, and their various uses. The object is to prepare the student for his subsequent work in *Engineering, Paleontology and Geology.*

ZOÖLOGY.

MR. SEAMAN.

Second Year.—Fall term, two hours a week for eight weeks.

This course is given by lectures and recitations, and its object is to give a general knowledge of the fundamental principles of *Zoölogy.* The work is given as a preface to the work in *Paleontology*, and particular attention will be given to those orders of animals which fúrnish the more common and characteristic fossils. Their structure and habitat will be briefly described, and the phylogenetic significance of ontogenetic facts will be pointed out. Attention will be called to the modes of life, habits, and peculiarities of animals, including their relation to man and his works.

Students will be given references to such books upon the subject, as their personal tastes may require.

PALEONTOLOGY.

MR. SEAMAN.

THIRD YEAR.—Fall term, four hours a week for eight weeks.

This course is given as an elementary one. The work, however, will be made as practical as possible, much of the time being spent in laboratory practice. The method of working will not differ materially from that pursued in *Mineralogy.* While much detail is left out, care will be taken to point out the principal characteristics by which fossils may be recognized and determined. A personal handling of the forms of living species will be insisted upon, so that the knowledge will be real as far as it goes. Special attention will be given to certain groups that yield common and characteristic fossils, and these will be treated more in detail. The manner of entombment, and the conditions under which organisms are preserved will be discussed. The relative importance of land and marine fauna, and flora, in determining the chronological sequence of the rocks of the earth's crust, will be considered. There is a working collection of nearly two thousand specimens, especially selected to cover the entire geological column. These will be used to drill the students in recognizing fossils in different states of preservation, in assigning them to their general orders, and in certain cases giving their generic names. The specimens are arranged unlabeled in drawers, for the students to work upon; and pains will be taken to train the eye to recognize resemblances and differences. There is also a small type collection of living and fossil forms, arranged zoölogically in accordance with the system of Nicholson's New "Manual of Palæontology;" and a larger one of fossils, containing over a thousand specimens, arranged mainly according to geological horizons. Students have free access to all collections. The text-books used are Wood's "Elementary Palæontology," supplemented by lecture notes, and Archibald Geikie's "Text Book of Geology", book V.

Regular students taking this course must have passed in the preceding courses in Botany and Zoology.

CRYSTALLOGRAPHY.

THE DIRECTOR, MR. SEAMAN AND MR. WRIGHT.

SECOND YEAR.—Fall term, twelve hours a week, five weeks.

Instruction in this subject is given by means of lectures and laboratory practice in determining the forms and planes of glass and wooden crystal models, and natural crystals, with recitations and examinations upon the same. The instruction is given in connection with the course in Mineralogy, and therefore is confined to training the student in that practical knowledge of crystal forms which he needs in his Determinative Mineralogy and Petrography. For purposes of instruction in this subject the laboratory is supplied with the following collections:

Crystal Models in Glass	151
Crystal Models in Wood and Plaster	2,153
Natural Crystals	1,800
	4,104

Regular students taking this work must have passed in all the preceding work in Physics and in Analytic Geometry of Three Dimensions.

MINERALOGY.

THE DIRECTOR, MR. SEAMAN AND MR. WRIGHT.

Second Year.—Fall term, twelve hours a week for nine weeks; winter term, twelve hours a week.

The work in *Determinative Mineralogy* is preceded by the course in *Crystallography* and by instruction in general *Physical* (including *Optical*) *Mineralogy*, although part of the instruction in these subjects is given as needed in connection with the *Descriptive Mineralogy*.

It is intended to give in the *Optical Mineralogy* all instruction necessary to precede the subsequent work in *Petrography*.

For *Determinative Mineralogy* there is provided a typical set of all the important minerals, special attention being paid to those of economic value, as well as to those occurring as gangue, or rock-forming minerals. Special collections are arranged showing the physical characters of minerals, their pseudomorphs, etc.

These minerals are arranged in drawers, labeled, and are at all times freely accessible to the student.

Besides the typical collection of minerals, there are placed in drawers a large number of specimens of the same mineral species. These are arranged in convenient groups, but are unlabeled. These specimens are selected so as to represent as great a variety of form, appearance and locality as possible, in order that the student may be familiar with all the types that he will be likely to meet with in his professional practice. Drawers of these unlabeled minerals are assigned to each student, who is required to determine them and to recite upon them. He is required to do that which the practical mineralogist does; to determine his minerals by the shortest method possible, consistent with accuracy; the method to vary according to the specimen. To this end every method of determination short of quantitative analysis is employed; that is, in each case the crystal form and other physical characters are used, as well as the blowpipe and wet tests, so far as they may be needed.

After the student has studied and recited upon the specimens contained in a sufficient number of drawers of one group, he is then assigned to drawers containing the unlabeled minerals of another group, which have mixed with them specimens of the preceding group or groups. In this way each student is required to determine in his course from 3,000 to 6,000 different mineral specimens, belonging to the 302 selected species.

The instruction is based on the sixth edition of Professor James D. Dana's *System of Mineralogy*, revised by Professor Edward S. Dana, 1892, and every student is expected to provide himself with a copy. In addition, or supplementary, to this work, there is given a series of lectures and notes by the Director, in which the characteristic features of each mineral, its uses, and the practical methods employed to distinguish each one, are pointed out. Especial attention is given to the methods needed in the field and mine, when one can not have recourse to a chemical laboratory. Every effort is made to train the student to close, accurate observation, to reason correctly upon what he sees, and to exercise good judgment in his decisions.

The result of this work is such that a student not only knows how to proceed, in order to determine any mineral that he may meet, but he is also enabled to recognize at sight, or by simple tests, the great majority of specimens belonging to the three hundred and two mineral species that he is required to study in his course.

During the summer term of 1892 the entire mineral collection was rearranged to correspond to the sixth edition of Dana's *System of Mineralogy*, with the exception of some modifications that, it was thought, would enable the student to do his determinative work in an easier and better way, (see Tables IV–X).

Beside the collections given under the head of Crystallography there are the following for use in the laboratory work in Mineralogy:

Collections illustrating Physical Properties, Pseudomorphs, Optical Properties, etc.			485
Lecture Collection			10.000
Practice Collection	First Series	2,500	17,025
	Second Series	2,100	
	Third Series	1,275	
	Fourth Series	3.225	
	Fifth Series	1,525	
	Sixth Series	1,850	
	Seventh Series	1,425	
	Review Series	3,125	
			27,510

In order that the special mineralogical work done in this institution may be better understood by persons seeking information upon this point, and in addition to serve as a guide to the pupil in referring to the lecture specimens, the appended tables IV–X are given of the species to be studied in the laboratory work in this course. The system of numbering is that adopted by Professors Brush, of Yale, and Cooke, of Harvard; the original-collection numbers increase by ten each time, in order to allow of interpolations of new specimens without having to re-number those already in the lecture collection.

The tables only show the numbers of the specimens belonging to the species upon which laboratory work is given, and not those of the other species represented in the lecture collection.

Regular students taking this course must have passed in the Chemistry and Physics of the first year, and the preceding Crystallography.

PETROGRAPHY.

THE DIRECTOR AND MR. SEAMAN.

THIRD YEAR.—Fall and winter terms, six hours a week. In this course the student is taught to use the microscope as a simple instrument, and also as a piece of optical apparatus for the determination of minerals and rocks.

The work is incidentally divided into three parts: *Microscopic Mineralogy*, *Lithology*, and *Petrology*.

Microscopic Mineralogy: Under this head is treated the various optical and other characters of minerals as revealed by the microscope. Their alterations are especially studied owing to the importance of these in the subject of Economic Geology.

In this elementary course the student is expected to do sufficient laboratory work to enable him to distinguish globulites, trichites, microlites, spherulites, aggregates, twinned crystals, fluid, glass and stone inclusions, isotropic and anisotropic bodies, uniaxial and biaxial crystals, positive and negative uniaxial and biaxial crystals; and to determine the axis of elasticity in a crystal plate, the extinction line of crystals, and the crystal system of plates in parallel polarized light. He is required to know the conditions necessary for the determination of uniaxial and biaxial crystals in converging polarized light; also pleochroism, how determined and for what use; the use of Newton's scale of colors and the use of the gypsum and mica plates, quartz wedge, and the Bertrand lens. He should be able to determine the following minerals, and give the characters that distinguish each one from the others: Graphite, pyrite, quartz (chalcedony), hematite, ilmenite, spinel (picotite), magnetite, chromite, rutile, zircon, opal, calcite, dolomite, orthoclase, microcline, plagioclase, leucite, enstatite (bastite), hypersthene, pyroxene (diallage, omphacite, and augite), amphibole (tremolite, actinolite and

hornblende), glaucophane, nephelite (elaeolite), sodalite, haüynite, noselite, garnet, chrysolite (olivine), andalusite (chiastolite), sillimanite (fibrolite), tourmaline, staurolite, titanite, muscovite, biotite, chlorotoid (ottrelite), chlorite, serpentine (chrysotile), talc, kaolinite, apatite and gypsum.

For the purpose of instruction there is used as a text book and laboratory manual, Rosenbusch's "Microscopical Physiography", translated by Joseph P. Iddings, Third Edition, 1893.

This is supplemented by a series of lectures given by the Director.

For the purpose of giving the above elementary, as well as graduate, instruction, the department is supplied, amongst other things, with the following apparatus:

Twenty-nine Bausch and Lomb's Petrographical Microscopes, made expressly for the Michigan Mining School; with Micrometer Eyepieces, Bertrand's Lenses, Quartz Wedges, Undulation Plates, etc.

Four Beck's Petrographical Microscopes with Accessories.

One Fuess's Largest Petrographical Microscope, of the *latest pattern*, with all the Accessories; made expressly for this institution.

One Nachet's Largest Petrographical Microscope, with all the Accessories.

One Dick's Petrographical Microscope, with Swift's Objectives and other Accessories.

One projection Microscope.

One Nachet's Inverted Chemical Microscope.

One Spectroscope.

One Spectropolarizer.

One Sorby's Apparatus for observing the four images given by biaxial bodies.

Two Calderon's Oculars.

Three Bertrand Oculars.

One Spectroscope Ocular.
One Goniometer Ocular.
One Babinet's Compensator Ocular.
One Michel-Levy's Comparateur.
One Axial Angle Apparatus for measurements in oil.
Two Axial Angle Apparatuses.
One Periscope Eyepiece.
One Filar Micrometer.
One Cross-hair Micrometer.
Three Micrometers.
Four Camera Lucidas.
Two Abbé's Camera Lucidas.
One Bausch and Lomb's One-inch Microphotographic Objective.
One Mica Plate Nose Piece.
Many Extra Eyepieces, Objectives, etc.
One Condenser.
One Condenser with Iris Diaphragm.
One Jannettaz's Thermal Apparatus.
One Latterman's Apparatus.
One Fuess's Polariscope with Accessories.
One Groth's Universal Apparatus, with Goniometer.
One Fuess's Application Goniometer for dull crystals.
One Fuess's Reflection Goniometer.
One Hirschwald's Microscope Goniometer.
One Linhof's Reflection Goniometer.
One Total Reflectometer Attachment.
Fourteen Miller's Goniometers.
One Stage Goniometer.
One Bertrand's Micro-goniometer with Special Stage.
One Flask for measuring Index of Fluids.
One Pyroelectric Duster.
One Streng's Chest and Apparatus, for Microchemical Reactions, etc, etc.
3752 Thin Sections of Rocks and Minerals.

Lithology: The instruction in this branch of *Petrography* comprises both macroscopic and microscopic study of rocks.

For this work large and complete collections of rock specimens, with numerous thin sections, are arranged for the use of the student. The course of instruction here is similar to that followed in the course in Mineralogy. Lectures are given upon the specimens of the typical collection, the method of classification explained, and the distinguishing characters of the different groups, species, and varieties pointed out. Special attention is called to the variations and alterations in rocks, and to their local modifications due to their special mode of occurrence in the field.

The object of the course is to give the student that training in the practical determination of rocks that will enable him to know them in the field and mine, as well as to observe their alterations and modifications—subjects that have a very important bearing upon the vital questions relating to ore deposits.

After the study of a sufficiently large number of types has been had, the student has assigned to him drawers containing unlabeled specimens of these rocks, which he is expected to determine and recite upon, as he has done in his study of the minerals. The course is thus made thorough and practical, and adapted to the needs of the miner and geologist, giving them a training which they can make use of in their future work.

The student is drilled at the same time upon both the microscopic and macroscopic characters of the rocks he is studying.

Besides between three and four thousand thin sections for microscopic work, for macroscopic work there are the following collections of rocks available for use in this course:

Lecture Collection	3,800
Practice Collection	6,500
Rosenbusch Collection	1,000
Collection of Michigan Rocks	275
	11,575

The subjoined classification of rocks, Table XI, will show the scope of the laboratory work and lectures, as the instruction in *Lithology* is given entirely by lectures and laboratory practice.

Petrology: Under this subdivision of *Petrography*, the various questions relating to the origin, modes of occurrence, relations and alterations of rocks, as observed in the field, are considered.

This subject is further considered under the head of *Physical Geology*.

Regular students taking this course must have completed the course in Mineralogy, Physics and the preceding General and Qualitative Chemistry.

STRATIGRAPHICAL GEOLOGY.

MR. SEAMAN.

THIRD YEAR. Winter term, five hours a week.

This course will consist of recitations and laboratory work, and will be given in continuation of the course in Paleontology. The object of the course will be to familiarize the student with the life history, lithological characters, mode of formation, and distribution in time and space, of the formations which compose the earth's crust.

In the laboratory the student will be drilled in determining the fossils in hand specimens, and in assigning the fossils so determined to their proper geological system. For this purpose there are available, the Paleontological collections of three thousand specimens, three small collections—one European and two American—containing 600 specimens arranged stratigraphically, and over one thousand specimens of sedimentary rocks belonging to the lithological collection. If time permits, there will be exercises in determining horizons, with the aid of paleontological literature, with which the library is well supplied.

In addition to the above, some time will be given to surface geology, in which the present contours of the land will be explained. The text-book is Dr. Archibald Geikie's "Text-Book of Geology," books VI and VII.

Regular students taking this course must have completed the preceding courses in Botany, Zoology, Paleontology and Physical Geology.

PHYSICAL GEOLOGY.

THE DIRECTOR.

THIRD YEAR.--Fall term, two hours a week, winter term, three hours a week.

The instruction in *Physical Geology* is intended to be especially adapted to the needs of the explorer, the engineer, the petrographer, the geologist, the miner, the quarryman, and of all others who desire to understand the connection and the structural relations that rock masses have to one another and to the valuable deposits which they may contain. It is intended to treat of the origin and alterations of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, cleavage, mountain building, eruptive rocks and crystalline schists; the

TABLE VI.

THIRD SERIES.—SEVENTEEN SPECIES.

Divisions.	Subdivisions.	Group.	Species.	Varieties.	Pages in Dana's System.	No. of Drawer.	First and last numbers of the Specimens.	No. of Specimens.
Carbonates.	Anhydrous Carbonates.	Calcite	Calcite	Dog-Tooth Spar Iceland Spar Satin Spar Marble Limestone Chalk Oolite Pisolite Stalactite Stalagmite Mexican Onyx Calc Sinter Calc Tufa Travertine	262-271	89-92	29040-29900	114
			Dolomite		271-273	92, 93	29920-30270	37
			Magnesite	Breunnerite	274, 275	93, 94	30460-30840	49
			Siderite	Spherosiderite Clay-ironstone	276-278	94-96	30850-31440	60
			Rhodochrosite	Manganocalcite Manganosiderite	278, 279	96, 97	31450-31780	38
			Smithsonite		279, 280	97, 98	31790-32300	58
		Aragonite	Aragonite	Stalactite Stalagmite Coralloidal, or Floss-Ferri	281-283	98-100	32310-32970	97
			Witherite		284, 285	101	33010-33220	25
			Strontianite		285, 286	101, 102	33230-33470	25
			Cerussite		286-289	102, 103	33475-34040	64
		Barytocalcite	Barytocalcite		289	103	34050-34090	8
	Hydrous Carbonates.	Malachite	Malachite		294, 295	104, 105	34110-34900	80
			Azurite		295-298	106, 107	34910-35650	82
			Hydrozincite		299	107	35670-35815	20
			Natron		301	107	35830-35900	4
			Hydromagnesite		304, 305	108	35930-35990	9
			Zaratite		306	108	36070-36100	7

CLASSIFICATION OF UTILITES OR USEFUL GEOLOGICAL PRODUCTS BASED ON THEIR USES.

TABLE XIII.

Utilites	Erites, or Metallites	Ores, or Metalliferous Materials.	
	Non-erites, or Menetallites, or Non-metalliferous Materials.	Tectonites	Construction Materials, or Building and Road Materials.
		Cosmites	Decorative Materials, or Ornamental Stones and Gems.
		Pyrolites	Refractory, or Fire-resisting Materials.
		Chalicites	Binding Materials, or Limes, Mortars, Cements, etc.
		Ceramites	Fictile, or Ceramic Materials.
		Rholites	Smelting Materials, or Fluxes.
		Vitrites	Vitrifying Materials, or Glass, etc.
		Tribolites	Abrasives, or Attrition Materials.
		Thermites	Fuels or Burning Materials, or Carbonites.
		Grapholites	Graphic, or Illustrative Materials.
		Lubricites	Lubricants, or Friction Materials.
		Chromatites	Color Materials, or Paints, Pigments, etc.
		Coprites	Fertilizers, or Mineral Manures.
		Salites	Salts and Saline Materials.
		Ignites	Pyrotechnic Materials.
		Pharmacites	Mineral Medicines.
		Chemites	Chemical Materials.

action of air, surface and underground waters, and life; the interior condition of the earth, etc., especially in their relations to the problems that the economic geologist, miner and quarryman have to meet. The student has brought before him constantly the various problems that arise in the practical work and their methods of solution.

The course is given by lectures and by recitations based upon the lectures and upon Dr. Archibald Geikie's *Text Book of Geology*, third edition, 1893, books I, II (part I), III and IV.

Regular students who take this course must have completed the preceding work in Physics, Chemistry and Mineralogy.

ECONOMIC GEOLOGY.

THE DIRECTOR.

FOURTH YEAR.—Fall term, five hours a week; winter term, five hours a week (elective).

In the old three years' course, the instruction is confined to the winter term of the third year, and is given in an abbreviated form. In 1893-1894 Kemp's "Ore Deposits" was used as the text book, but was supplemented by numerous lectures. In the four years' course, the instruction will take up the geology of the useful, or economic, mineral products in two different ways.

1st, Their origin and modes of occurrence.

2nd, Their uses.

The general ground covered by lectures relating to the modes of occurrence of products treated in the course of Economic Geology is shown in Table XII; while that covered by the lectures relating to the uses of these products is shown in a general way by Table XIII.

Special attention is given to the instruction of the student in Mineralogy, Petrography and Geology, in order that he may in after years understand the nature of the deposits upon which he may be at work; since disastrous mistakes probably occur in the practice of a mining engineer oftener through ignorance of the petrographical and geological relations of the ore deposits in question, than from a lack of engineering or metallurgical skill.

The location of the school affords special advantages for the study of Petrography and General and Economic Geology. It is situated in the midst of the vast and ancient lava flows and conglomerates generally known as the Copper-bearing or Keweenawan series, and near the Eastern or Potsdam Sandstone. In the immediate vicinity are to be solved some of the most important and fundamental problems of petrographical and geological science, e. g. the metamorphism, or alteration of rocks; the true age of the so-called Keweenawan series; the relation of the so-called Huronian and Laurentian series; the origin of the iron ore, etc.; while almost every problem of Geology finds its illustration in some portion of the Upper Peninsula.

The instruction in the various departments under the charge of the Director is intended to be given so that all those who wish to obtain a knowledge of the subjects as a matter of general information, or to prepare themselves to be teachers or investigators, can attend with advantage.

Regular students who take this course must have completed the preceding work in Physics, Elementary Chemistry, Qualitative Analysis, Mineralogy, Petrography and Geology.

FIELD WORK IN GEOLOGY.

THE DIRECTOR AND MR SEAMAN.

THIRD YEAR.—Summer term, forty-five hours a week, six weeks.

Part of the summer term of the third year is spent in the field and about the mines, in the practical study of various questions in General and Economic Geology, Mineralogy and Petrography.

In order to increase the usefulness of the Mining School, by enabling persons to take some of its courses of instruction, the summer work in *Geology, Shop Practice, Ore Dressing, Assaying, and Surveying*, is open to all properly prepared persons. All candidates for a degree in this institution are required to take all this work, as it is a part of the regular course. The summer course in Geology will commence early in July and continue for six weeks. The course consists essentially in the examination and discussion of observed phenomena of the sedimentary and eruptive rocks, whether metamorphic or not, as well as of the associated ores to be seen in the Upper Peninsula of Michigan. The work, for the most part, will be done in the vicinity of the mines, and students will be expected to make maps, notes, sections, diagrams, etc.

Special instruction is given in geological wood craft and surveying, like finding quarter posts, tracing section lines, finding and locating outcrops, tracing dikes and veins, distinguishing geological formations, their distribution and relations, etc.

For purposes of instruction, this department is well supplied with dial and dip compasses and barometers.

During the summer of 1893, the class worked in the Marquette, Menominee and Gogebic Iron districts, and in 1894 the work will be done along the shore of Lake Superior and in the Marquette Iron district, as this region offers the most varied and extended problems of almost any district of its size in the world.

The student of geology can study within the limits of the Upper Peninsula of Michigan the following stratigraphical formations, commencing in the list with the oldest:

Azoic or Archaean System....	Laurentian (?) Period	Cascade Formation.
	Huronian (?) Period..	Republic Formation. Mesnard Formation.
	Michigan Period.	Holyoke Formation. Negaunee Formation.
Paleozoic System....	Cambrian Period.. ...	Potsdam Formation. [Keweenawan Formation.] Calciferous Formation.
	Silurian Period	Trenton Formation. Hudson River Formation. Niagara Formation. Onondaga Formation. LowerHelderbergFormation.
	Devonian Period	UpperHelderbergFormation.
Anthropozoic or Anthozoic System....	Quaternary Period ..	Pleistocene Formation. Recent Formation.

THESES.

Every student who is a candidate for the degree of Mining Engineer in the four years course is required to present to the Faculty a satisfactory thesis giving the results of original work in some subject related to the studies of the course, before he can be recommended to receive his degree. Students who intend to graduate in any year are required to select their subjects and present them to the Faculty for approval during the fall term of that school year.

The theses are required to embody the results of some investigation, followed under the direction of one or more of the teachers in the school; and to be accepted, they need to possess considerable merit, and to give evidence to thorough work.

Candidates for the degree of Bachelor of Science are not required to present any thesis.

ORGANIZATION.

The Michigan Mining School is an Institution established and supported by the State of Michigan, in accordance with that liberal educational policy which has placed the University of Michigan amongst the foremost educational institutions of America.

The Mining School is organized under the authority of an Act, approved May 1, 1885, portions of which are as follows:

"SECTION 1. The people of the State of Michigan enact: That a school shall be established in the Upper Peninsula of the State of Michigan, to be called the Michigan Mining School, for the purpose and under the regulations contained in this Act.

"SEC. 2. The said school shall be under the control and management of a board of six members, not less than four of whom shall be residents of the Upper Peninsula of the State of Michigan, who shall be known as the 'Board of Control of the Michigan Mining School,' and who shall be appointed by the Governor of the State of Michigan, by and with the consent of the Senate, (* * * *) and who shall serve without compensation.

"SEC. 5. The course of instruction shall embrace geology, mineralogy, chemistry, mining and mining engineering, and such other branches of practical and theoretical knowledge as will, in the opinion of the board, conduce to the end of enabling the students of said Institution to obtain a full knowledge of the science, art and practice of mining, and the application of machinery thereto. Tuition shall be free in said Institution, to all bona fide residents of this State, but a reasonable charge for incidental expenses, not less than ten dollars nor exceeding thirty dollars per year, may be made against any student, if deemed necessary, and the board shall not be obliged to furnish books, apparatus, or other materials for the use of students.

"SEC. 6. The course of study, the terms, and the hours of instruction, shall be regulated by the board, who shall also have power to make all such rules and regulations concerning admission, control and discipline of students, and such others, as may be deemed necessary for the good government of the Institution and the convenience and transaction of its business.

"SEC. 7. No debt shall be contracted beyond or apart from the actual means at the disposal of the Institution. The board may dispose of, or lease any property donated to the State for said School, or which may be acquired in payment of debts, except of such as is necessary for the accommodation of the school. * * * * * * "

In conformity with the above act, the Michigan Mining School was first opened to students September 15, 1886, and has been made free to students from every land. All are received on the same conditions, no matter where their residence may be.

EXPENSES.

Under the act of organization, the Board of Control have made the school entirely free, no charge being made for tuition or incidentals, whether the student was a resident of the State of Michigan, or of the United States, or not; all has been made free to the students from every land. The supplies in the chemical and allied laboratories are furnished the students, and they are required to pay for materials, re-agents, etc., and for the use and breakage of apparatus.

All students working in the Chemical Laboratories are required to pay ten dollars a year, which general charge covers all chemicals, gas, use of balances, etc. Students taking the course in Assaying are required to pay four dollars for the first year, and eight dollars for the second year.

In order partially to insure the State against damage and loss to its school property, every student is required to deposit with the Treasurer the sum of twenty-five dollars ($25). This sum shall not be withdrawn by the student until he closes his connection with the School; and if any portion is required by the School as a refund for damages, the part withdrawn shall be at once replaced by the student, or he shall be dismissed from the school.

Charges for apparatus, chemicals and other supplies from the store room, as well as for repairs of damages to school property, and also fines, shall be deducted from coupons procurable from the Clerk upon payment of five dollars each, but no portion of the twenty-five dollars above mentioned shall be used for the purchase of these coupons.

The permanent deposit of twenty-five dollars, together with any balance equivalent to the unused portion of a coupon, shall be returned to the student when he closes his connection with the school, but not before.

Each student is required to present to the Director his certificate of deposit from the Treasurer, at the commencement of each school year, or at such time thereafter as he may present himself at the School for work. The Director may then issue an annual certificate of membership to the student, subject to the subsequent approval of the Faculty.

No student shall be considered a member of the School, or allowed to join in any of the exercises, or to take any apparatus, chemicals, books, etc., until he shall have presented to the Instructor, Librarian and Dispensing Clerk, his certificate of membership for that school year.

It shall be the duty of the Treasurer to have printed such coupons as are needed. These shall be deposited with the Clerk, the Treasurer taking his receipt therefor. The Clerk shall pay over to the Treasurer all money received from the student in payment for the coupons, taking his receipt therefor. The accounts of the Clerk shall be audited every year; at which time the Clerk shall show to the Auditing Committee, Treasurer's receipts and unused coupons amounting in value to all the coupons deposited with him by the Treasurer, before the Clerk's accounts shall be adjusted.

There are no dormitories connected with the School. Arrangements can be made by those who desire to do so, to obtain board and rooms in private families, and in boarding houses, in Houghton and Hancock, at prices varying from twenty to twenty-five dollars per calendar month. Twenty-two to twenty-three dollars per month is understood to be the standard average price. This is to include the room, heat and lights, as well as board. Board alone can be obtained at from seventeen to twenty dollars per calendar month.

The necessary expenses of the students are estimated by them as follows, for each year:

Board, etc., 10½ months at $20.00 to $25.00	$210 00	to	$262 50
Apparatus, Chemicals, etc.	20 00	to	40 00
Books and Drawing Materials	25 00	to	50 00
Traveling Expenses (Excursions, Field-work, etc.)	10 00	to	50 00
Washing	20 00	to	30 00
Total	$285 00		$432 50

PRIZES AND SCHOLARSHIPS.

THE LONGYEAR PRIZES.

Through the liberality of Hon. J. M. Longyear, of Marquette, the following prizes have been offered, as stated in his letter making the offer, which is here appended:

Marquette, Michigan, Nov. 9, 1887.

CHARLES E. WRIGHT, ESQ., MARQUETTE:

DEAR SIR—I wish to offer three first prizes of seventy-five dollars ($75) each, and three second prizes of fifty dollars ($50) each, to be competed for by the members of the senior class of the Michigan Mining School. The competition to be by means of papers on three subjects, written by members of the class, and submitted to the Board of Control for examination, in such a manner and at such a time as the Board may determine. I desire subjects selected with a view of producing papers which will be of practical use in developing the mineral resources of the State of Michigan. I should like something which would be of service to the average woodsman or explorer, and suggest the subjects of Practical Field Geology, and the use of the Dial and Dip Compass in explorations; leaving the selection of the third subject to the judgment of the Board. If this offer is accepted, and there are two or more papers on each subject submitted, I will pay seventy-five dollars to each of the writers of the three papers which may be awarded the first prizes, and fifty dollars to each of the writers of the three papers which may be awarded the second prizes.

I would suggest, however, that in case only two papers are submitted, that the Board reserve the right of awarding only one prize, in case such action should seem advisable. In case only one paper should be submitted, I should like the Board to exercise its judgment in awarding a prize. It is my desire to publish the papers under the writers' names, in pamphlet form, for distribution among miners, explorers, land owners, and others.

Yours very truly,
J. M. LONGYEAR.

In conformity with the foregoing letter, the Board of Control have decided upon the following subjects and conditions:

SUBJECTS.

1. Field Geology; its Methods and their Applications.
2. The Dial and the Dip Compass and their Uses.
3. The Diamond Drill and its Uses.

CONDITIONS.

The conditions under which the prizes are awarded are as follows:

The papers are to be presented by September 30th, for each year.

A student may present a paper upon each of the three subjects, which will entitle him to three prizes, if his papers are found worthy.

The dissertations must be prepared in the same manner as the theses, the regulations for which can be procured on application to the Secretary of the School.

The title page is to have upon it an assumed name, and each dissertation is to be accompanied by a sealed envelope bearing the same name. This envelope must contain the writer's true, as well as assumed, name, and his address, and it will not be opened until the awards have been made.

No prizes will be awarded, unless the papers are judged by the committee to whom they are referred, to be of a sufficiently high standing to be entitled to a prize; hence there may be awarded all, part, or none of the prizes, as the case may be.

These prizes can now be competed for by any students of the school, whether special, graduate or regular, without restriction to the graduating class, as was originally

THE CHARLES E. WRIGHT SCHOLARSHIP.

The Charles E. Wright Scholarship has been founded by Mrs. Carrie A. Wright, of Ann Arbor, in accordance with the conditions expressed in the letter given below:

To the Honorable Board of Control of the Michigan Mining School:

GENTLEMEN:—In memory of my husband, the late Charles E. Wright, and as a token of the deep interest he had in the Michigan Mining School, I desire to give to said school the sum of one thousand dollars.

If said gift shall be accepted, it is to be held under the following conditions, to-wit: It is to be invested as a permanent fund, by the Board of Control, to form the nucleus of a scholarship to be known as the Charles E. Wright Scholarship The income is be given to some indigent student, by vote of the Board of Control, with the advice and consent of the faculty of said school.

The award is to be made during the first term of the year, to some student who has a satisfactory record during the entire preceding year in the Michigan Mining School, and who intends to devote himself to the profession of Mining Engineering or Geological work. The income is to be divided into three equal parts, to be paid during the three terms of the year, and if at any time the conduct or standing of the student receiving the award should become unsatisfactory, the portion then remaining unpaid should be withheld from him, and given to some other student, in accordance with the terms of this gift.

(Signed) CARRIE A. WRIGHT.

THE NORRIE SCHOLARSHIP.

This scholarship has been founded, and will be awarded, in accordance with the conditions and requirements stated below:

Know all men by these presents, That I, A. Lanfear Norrie, of the city of New York, hereby give, grant, assign, and set over unto, the Michigan Mining School, of Houghton, Michigan, and to

Peter White, D. H. Ball and J. M. Longyear, of Marquette, Michigan, as trustees, the sum of five thousand dollars ($5,000), lawful money of the United States.

The conditions of this gift, and upon which this fund is to be taken, are, that the said trustees shall invest the same upon bond and mortgage in the village of Marquette, or in the city of Detroit, in the State of Michigan, or in the city of Milwaukee, in the State of Wisconsin, or in the city of Chicago, in the State of Illinois, upon unencumbered improved real estate.

That one-half of the income of said sum of $5,000 shall be paid yearly by said trustees unto the Board of Control, for the support of some student whose father has worked in, or in some way been connected with, mining operations in the Upper Peninsula of Michigan, who shall be designated by the faculty of said school; and the remainder of said income shall be accumulated and invested as said principal shall be invested, and that this fund with its accumulations shall be the basis of a larger fund, to be obtained from other contributions, amounting to at least one hundred thousand dollars ($100,000), to be used for the erection of a Dormitory Building, for the use of such students as shall be designated by said faculty; which building, when erected, shall be under the exclusive control of the corporation or Board of Control of the said Michigan Mining School.

This gift is to the said trustees and their successors forever, for the benefit of the said Mining School. In case of the death of either of said trustees, the survivors or survivor shall appoint a successor or successors.

When the erection of said building shall be commenced, after the said fund of one hundred thousand dollars is obtained, the sum hereby given, with all its accumulations, shall be paid over to the said Mining School, for the purpose aforesaid.

Witness my hand, the 30th day of January, 1890.

A. Lanfear Norrie.

Witness, T. E. O. M. Stetson.

We, Peter White, D. H. Ball and J. M. Longyear, the persons named in the above instrument, accept the trust therein granted, in all respects, and agree to comply with the conditions thereof.

Witness our hands, the 1st day of February, 1890.

Peter White,
D. H. Ball,
J. M. Longyear.

THE LONGYEAR FUND.

This is a fund of $500.00, given for the year 1892-93, by Mr. J. M. Longyear, of the Board of Control, to be the property of the Mining School, to be loaned to students of said school who may be designated by the Treasurer and Director, said students being unable to maintain their connection with the school without such aid. This money is not to be a gift to the student, but he is to pay it back as soon as practicable after graduation. After his graduation, interest will be charged him for the first three years at 5 per cent, and for the following two years at 7 per cent. The money and the interest are to go to the fund, to aid other students in the same way. This method, it is believed, will lead the student to a more manly feeling than a gift outright would produce in him, since it gives him the means of paying for his own education, assists him when he most needs assistance, and enables him to return the money to aid others, at a time when he can best do so.

It is believed that it would be better if all funds given to the School for investment and use, should be accompanied by some proviso that a certain portion, at least, of the income shall be saved or set aside, to increase the principal until it shall attain a limit, either fixed, or left to the proper authorities to determine. Such a method would enable the institution in the future to do much more good, than it would if the income were to be spent entirely each year.

The School is in great need of funds to aid students who would otherwise be unable to attend this institution. Aid of this kind is frequently sought by able and worthy young men, and all is done that can be, with the limited means at the command of the School, to aid them.

The Longyear Fund has been continued for three years, and now amounts to $1,500.00, but no part of it is available in 1893-1895.

DEGREES AND GRADUATE INSTRUCTION.

Students who have graduated in the former two years course of the school with the degree of Bachelor of Science, may obtain the degree of Mining Engineer, by returning to the school and completing the course given at the time of such return: or else they may receive it upon application to the Board of Control and Faculty, and upon presentation of satisfactory evidence of five years' successful practical work, and of a suitable thesis in some line co-ordinate with their course of study in this school.

The thesis must be an original investigation undertaken in Mining, Mechanical or Electrical Engineering, Chemistry, Metallurgy, Petrography, Geology, or in some allied subject that shall belong within the objects of this institution; and it must be approved by the Faculty.

Students who complete the old course of three years, and present a satisfactory thesis, will receive the degree of Mining Engineer, or Engineer of Mines (E. M.). The thesis must conform to the requirements given above and must be completed and approved by the Faculty before that body will recommend that the Degree of Mining Engineer, or Engineer of Mines, be conferred upon the student.

Students who complete the new three years course and graduate, will have conferred upon them the degree of Bachelor of Science.

Students who complete the four years course and present a satisfactory thesis will receive the degree of Mining Engineer.

Students who are graduates of this, or of other institutions of high grade, will be admitted as special students to take any study taught in this school, or to take special graduate instruction.

Those who wish to become candidates for a higher degree will enter under the following conditions:

Students who are graduates of this institution, or of others of similar grade, whose course shall be approved by the Faculty, will be admitted as candidates for the degree of Doctor of Philosophy. In order to attain this degree they must pursue for at least two years an advanced course of study in subjects germane to the undergraduate course in this institution, which course of study is to be approved by the Faculty.

One of the years of study may, in special cases, be spent elsewhere, and the work accepted, on sufficient proof of its thoroughness and high character, as the equivalent of one year's work spent here. But under no condition will the degree be given, unless one year at least is spent as a resident worker at this institution.

Students who are graduates both of this, or of an equivalent professional school, and also of some college or university whose course of study is accepted by the Faculty, may be admitted to the degree of Doctor of Philosophy, after having taken for at least one year an approved course of study at this institution.

The degree of Doctor of Philosophy will be given only in case the student shall have shown marked ability and power for original investigation, shall have passed a satisfactory oral public examination, and presented a thesis, embodying the result of original investigation, that shall be approved by the Faculty.

Students who are graduates of this or of other institutions having a satisfactory equivalent course, and who shall have pursued here, according to the above regulations, a successful course of study for the degree of Doctor of Philosophy, may at the same time receive the degree of Mining Engineer, if said degree has not been conferred at their previous graduation.

GRADUATES, 1888.

NAME.	RESIDENCE AND OCCUPATION.
Harris, John Luther, S. B.	Quincy. Mining Engineer, Quincy Mine.
Longyear, Edmund Joseph, S. B.	Hibbing, Minnesota. Superintendent of the Longyear and Bennett Explorations.
Parnall, Samuel Alexander, S. B.	In charge of Installation, Electric Haulage Plant, Cleveland and Iron Cliffs Mining Company.
Parnall, William Edward, S. B.	Ishpeming. Electrical Engineer, Cleveland and Iron Cliffs Mining Company.
Reid, William Joseph, S. B.	Romeo.
Seager, James Benjamin, S. B.	Hancock. Superintendent of the Lake Superior Redstone Company.
Uren, William John, S. B.	Hancock. Civil Engineer, Mineral Range and Hancock and Calumet Railroads, and County Surveyor, Houghton County.

GRADUATES, 1889.

NAME.	RESIDENCE AND OCCUPATION.
CROZE, WALTER WILFRED JOSEPH, S.B.	Houghton. Mining Engineer.
FARWELL, PAUL, S. B.	Denver, Colo. Chemist.
*FESING, HERMAN WILLIAM, S.B.	Crystal Falls. Civil and Mining Engineer.
*HAAS, JACOB, S. B.	Marcus, Washington. Mining Engineer, Skylark Mine.
HOATSON, JOHN, S. B.	Butte City, Montana. Mining Engineer, Butte and Boston Mining Company.
PRYOR, REGINALD CHAPPLE	Houghton. Civil and Mining Engineer.

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* See Graduates of 1890 for the second degree.

GRADUATES, 1890.

NAME.	RESIDENCE AND OCCUPATION.
DANIELL, JOSHUA, S. B.	Great Falls, Montana. Blast Furnace Foreman, Boston and Montana Consolidated Copper and Silver Mining Company.
DRAKE, FRANK, S. B.	Boston. Metallurgy and Ore Dressing. Mass. Institute of Technology.
FESING, HERMAN WILLIAM, S.B., E.M.	Crystal Falls. Civil and Mining Engineer.
HAAS, JACOB, S. B., E. M.	Marcus, Washington. Mining Engineer Skylark Mines.
HODGSON, WILLIAM ADAMS, S. B.	Houghton. Thomson and Hodgson Company, Stephens, Ark.
SUTTON, LINTON BEACH, S. B.	Gould, Mont. Mining Engineer, Tremont Gold Mining and Milling Company.
WAKEFIELD, ARTHUR ALBERT, S. B.	Velardena, Durango, Mexico. Mining Engineer.

GRADUATES, 1891.

NAME.	OCCUPATION.
Bossert, Otto Henry, E. M.	Freiberg, Saxony. Mining Engineering, Bergakademie.
Dengler, Theodore, E. M.	Houghton. Mining Engineer, Atlantic Mining Company.
Fink, Edward, E. M.	Charlottenburg, Prussia. Organic and Technical Chemistry, Polytechniche Hochschule.
Lawton, Nathan Oliver, S. B.	Ironwood. Chief Mining Engineer, the Penokee and Gogebic Development Company.

GRADUATES, 1893.

NAME.	RESIDENCE AND OCCUPATION.
ABBOTT, AI ARTHUR, S. B., E. M.	Houghton. Instructor in Drawing, Surveying and Mechanical Engineering, Michigan Mining School.
CHURCH, GEORGE BATCHELOR, E. M.	Chicago. Civil Engineer.
FISHER, JAMES, E. M.	Hancock.
GILLIS, DONALD, E. M.	Butte, Montana. Assistant Assayer of the Parrott Mining and Smelting Company.
KIRK, MARCUS EUGENE, E, M.	Auraria, Lumpkin Co., Ga. Mining Engineer and Prospector.
MCDONALD, ERWIN HUNTINGTON, E. M.	Deer Lodge, Mont. Professor of Mining Engineering, College of Montana.
TRENGOVE, SAMUEL REED, E. M.	Lake Linden. City Engineer, Red Jacket.
WATERS, ALBERT LATCHA, S. B., E. M.,	Blue Spring Station, Bradley Co., Tenn. Superintendent of the Smelting and Concentrating Works, Blue Springs Mining Company.

OFFICERS OF THE YOUNG MEN'S CHRISTIAN ASSOCIATION.

President	William Wraith.
Vice-President	Bamlet Kent.
Treasurer	Milton Watson Coleman.
Recording Secretary	Elmer Whipple Durfee.
Corresponding Secretary	John Forrest Orr.

CLASS OFFICERS.

CLASS OF 1894.

President	Frederick Peck Burrall.
Vice-President	Carlton Franklin Moore.
Secretary and Treasurer	John George Kirchen.

CLASS OF 1895.

President	Love Dockery.
Vice-President	Robert Selden Rose.
Secretary	Milton Watson Coleman.
Business Committee	William Wearne. Milton Watson Coleman. Carl Raymond Davis.

FRESHMAN CLASS.

President	Williard Joseph Smith.
Vice-President	William Irving Aldrich.
Secretary	Elton Willard Walker.

OFFICERS OF THE ATHLETIC ASSOCIATION.

President....................Carl Raymond Davis.
Vice-President.........Henry Hoffman Holbert.
Secretary and Treasurer...Elton Willard Walker.

HOLDERS OF SCHOLARSHIPS.

THE NORRIE SCHOLARSHIP.

1893 1894.......................Robert Murray, Jr.

THE WRIGHT SCHOLARSHIP.

1893 1894...... ....John Alexander Knight.

OFFICERS OF THE ALUMNI ASSOCIATION.

President.................William John Uren, '88.
Vice-President.... ....John Luther Harris, '88.
Secretary and Treasurer,
Walter Wilfred Joseph Croze, '89.

COLLECTIONS.

For purposes of illustration and study, a number of collections have been provided for the use of the students.

Crystal Models	2,304
Natural Crystals	1,800
General Mineral Collection	27,310
Emerson Collection of Minerals	550
Exhibition Collection of Minerals	1,000
Collection of Thin Sections	3,500
General Rock Collections	11,575
Stratigraphical and Illustrative Collections	500
Collection of Economic Geology	1,000
Zoölogical Collection	1,000
Paleontological Collections	2,600

Besides the above, there are collections of paleontological charts, metallurgical, geological, and petrographical diagrams, geological models, maps, etc.

Collections of slags, metallurgical products, materials for illustration in economic geology, as well as some exhibition collections, have been commenced, and all persons who can are urged to contribute to the school collections of minerals, rocks, veinstones, ores, slags, metallurgical products, samples of building stones, machinery, tools, etc., and models, photographs and prints of the same, etc.

In the case of the mineral products used in arts and manufactures, it is desired to procure specimens showing the various stages in the process of manufacture. It is especially important for the School to receive and preserve sets of cores from drill holes, samples of ores from every mine, with specimens of the associated gangue minerals and rocks, as well as of the walls and associated country rocks.

LIBRARY.

The Library of the School contains at present 10,159 volumes, besides numerous pamphlets; and additions are constantly made to it. It is proposed to have not only a good reference library for student work, but also one that shall be as complete as possible upon the subjects taught in the school. It is especially desired to have a full set of all reports and works relating to the mining and other mineral industries of the districts bordering on Lake Superior. The library is now valuable for reference, both for practical and scientific men; and it is freely open to all who desire to consult it.

In addition to the school library, the scientific library of the Director is deposited in the school building, and can be used by students and others. This library is especially devoted to Crystallography, Mineralogy, Petrography and General and Economic Geology.

Contributions of pamphlets, papers, maps and books, on subjects germane to those taught in this institution, are solicited for the Mining School Library. Plans, drawings and engravings, relating to mines, mining machinery, and metallurgy, are desired.

It is hoped to make the Library very full in files of the different journals published throughout the country, especially in the mining regions: contributions of present and past numbers of such journals are solicited for the library, to aid in making it a complete depository of literature relating to the progress and industries of the country, as well as of the Lake Superior region.

READING ROOM.

Connected with the Library is a Reading Room, which is well supplied with scientific periodicals, technical journals, and the transactions and proceedings of scientific societies. The importance of periodical literature as a means of bringing before the student the results of scientific investigations is fully realized, and the collection is made as complete as possible for this reason. Below is given a full list of the journals on file, numbering in all two hundred and nine.

Contributions of journals for the Reading Room are earnestly solicited from publishers throughout the State and country.

*Alpena Pioneer, Alpena.
American Chemical Journal, Baltimore.
American Engineer and Railroad Journal, New York.
†American Geologist, Minneapolis.
American Journal of Mathematics, Baltimore.
†American Journal of Science, New Haven.
American Machinist, New York.
†American Naturalist, Philadelphia.
*American School Commissioner, Saginaw.
Annalen des K. K. Naturhistorischen Hofmuseums, Wien.
†Annalen der Physik und Chemie, Leipzig.
†Annalen der Physik und Chemie, Beiblätter, Leipzig.
†Annalen der Physik und Chemie (Electrotechnische Bibliographie), Leipzig.
Annalen de Chimie et de Physique, Paris.
†Annales de la Société Géologique de Belgique, Liège.

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*Gift of Publishers.
†A complete set of this Publication is in the Library.

†Annales des Mines, Paris.
Annales des Ponts et Chaussées, Paris.
Annales des Sciences Géologiques, Paris.
Annals of the New York Academy of Science, New York.
Annals of Mathematics, University of Virginia.
*Ann Arbor Argus, Ann Arbor.
*Arbetaren, Cadillac.
*Belleville Enterprise, Belleville.
*Bellevue Gazette, Bellevue.
Berg-und Hüttenmaennisches Jahrbuch, Vienna.
†Berg-und Hüttenmaennisches Zeitung, Leipzig.
†Berichte der Deutschen Chemischen Gesellschaft, Berlin.
*Boyne Falls News, Boyne Falls.
*Brickmaker, Chicago.
*Brick Roadways, Chicago.
*Bronson Journal, Bronson.
*Brown City Banner, Brown City.
Builder, London.
†Bulletin of the Essex Institute.
†Bulletin of the Geological Society of America, Rochester, N. Y.
Bulletin of the New York Mathematical Society, New York.
†Bulletin of the Philosophical Society, Washington.
Bulletin de la Société Chemique de Paris.
Bulletin de la Société Francaise de Minéralogie, Paris.
Bulletin de la Société Géologique de France, Paris.
*Calumet Conglomerate, Calumet.
*Calumet and Red Jacket News, Calumet.
*Canadian Mining Review.
*Capac Journal, Capac.
*Cass City Enterprise, Cass City.
†Cassier's Magazine, New York.
*Century Magazine, New York.
Chemical News and Journal of Physical Science, London.
Chemiker Zeitung, Cöthen, Germany.

†Chemische Industrie, Berlin.
Civilingenieur, Leipzig.
Colliery Engineer, Scranton, Pennsylvania.
†Comptes Rendus, Hebdomadaires des Séances de l'Académie des Sciences, Paris.
Copper Country Evening News, Calumet.
*Current, Norway.
*Daily Mining Journal, Marquette.
*Detroit Free Press, Detroit.
*Detroit Journal, Detroit.
*Diamond Drill, Crystal Falls.
†Dingler's Polytechnisches Journal, Stuttgart.
Electrical Engineer, New York.
†Electrical World, New York.
Electrician, London.
Electrotechnische Zeitschrift, Berlin.
Engineer, London.
†Engineering, London.
†Engineering Magazine, New York.
Engineering Mechanics, New York.
†Engineering and Mining Journal, New York.
Engineering News and American Railway Journal, New York.
*Ely Times, Ely, Minnesota.
*Escanaba Iron Port, Escanaba.
*Evening Journal, Flint.
*Evening News, Detroit.
*Florence Mining News, Florence, Wisconsin.
*Forum, New York.
Génie Civil, Paris.
Geographical Journal, London.
†Geological Magazine, London.
*Gogebic Iron Spirit, Bessemer.
*Good Health, Battle Creek.
*Grand Traverse Herald, Grand Traverse.
*Harper's Magazine, New York.

*Harvard University Bulletin, Cambridge, Mass.
*Imlay City Record, Imlay City.
*Industries and Iron.
*Ingham County Republican, Leslie.
Iron Age, New York.
*Iron Ore, Ishpeming.
*Ironwood News Record, Ironwood.
*Ironwood Times, Ironwood.
†Jahres-Bericht der chemischen Technologie, Leipzig.
†Jahresbericht über die Fortschritte der Chemie, Braunschweig, Germany.
Jahrbuch für das Berg-und Hüttenwesen, Freiberg.
†Jahrbuch der kaiserlich königlichen geologischen Reichsanstalt, Vienna.
†Jahrbuch der königlich preussischen geologischen Landesanstalt und Bergakademie, Berlin.
†Journal of Analytical and Applied Chemistry, Easton, Pa.
†Journal of the Association of Engineering Societies, Chicago.
†Journal of the Chemical Society, London.
Journal of Education, Boston.
Journal of the Franklin Institute, Philadelphia.
†Journal of Geology, Chicago.
Journal of the Iron and Steel Institute, London.
Journal für praktische Chemistry, Leipzig.
Journal of the Society of Arts, London.
Journal of the Society of Chemical Industry, London.
Justus Liebig's Annalen der Chemie, Leipzig.
Kritischer Vierteljahresbericht über die Berg-& Hüttenmännische und verwandte Literatur, Freiberg.
L'Anse Sentinel, L'Anse.
Lapeer Clarion, Lapeer.
Library Journal, New York.
†Library Notes, Boston, Mass.
*Literary News, New York.

†London, Edinburgh and Dublin Philosophical Magazine and Journal of Science, London.
Lumière Electrique, Paris.
*Lyons Herald, Lyons.
*Manistique Semi-Weekly Pioneer, Manistique.
Manufacturer and Builder, New York.
*Maple Rapids Dispatch, Maple Rapids.
Mathematical Magazine, Washington.
Mathematical Visitor, Washington.
†Memoirs of the American Academy of Arts and Sciences, Boston.
†Memoirs of the Boston Society of Natural History, Boston.
*Menominee Democrat, Menominee.
*Michigan Copper Journal, Hancock.
Michigan School Moderator, Lansing.
*Michigan State Democrat, Cadillac.
*Milan Leader, Milan.
Mineralogical Magazine and Journal of the Mineralogical Society, London.
Mineralogische und petrographische Mittheilungen, Vienna.
Mining and Scientific Press, San Francisco.
*Mining and Scientific Review, Denver.
*Native Copper Times, Lake Linden.
†Nature, London.
†Neues Jahrbuch für Mineralogie, Geologie und Palæontologie, Stuttgart.
*Newaygo County Democrat, Newaygo.
*North American Review, New York.
*Northwest Mining Review, Spokane, Washington.
*Oakland County Post, Pontiac.
†Oesterreichische Zeitschrift für Berg-und-Hüttenwesen, Vienna.
*Official Gazette of the U.S. Patent Office, Washington.
*Ontonagon Herald, Ontonagon.

*Ontonagon Miner, Ontonagon.
*Owosso Press, Owosso.
*Peninsular Record, Ishpeming.
†Petermann's Mittheilungen aus Justus Perthes' Geographisches Anstalt, Gotha.
†Philosophical Transactions of the Royal Society of London, London.
*Physician and Surgeon, Ann Arbor.
*Pick and Axe, Bessemer.
*Pontiac Gazette, Pontiac.
†Popular Science Monthly, New York.
*Portage Lake Mining Gazette, Houghton.
*Port Huron Weekly Times, Port Huron.
Power, New York.
†Proceedings of the Academy of Natural Sciences, Philadelphia.
†Proceedings of the American Academy of Arts and Sciences, Boston.
†Proceedings of the American Association for the Advancement of Science, Salem, Massachusetts.
†Proceedings of the Boston Society of Natural History, Boston.
†Proceedings of the Institution of Civil Engineers, London.
†Proceedings of the Institution of Mechanical Engineers, London.
Proceedings of the Geologists' Association, London.
Proceedings of the London Mathematical Society.
Proceedings of the Royal Geographical Society and Monthly Record of Geography, London.
†Proceedings of the Royal Society of London.
†Publishers' Weekly, New York.
†Quarterly Journal of the Geological Society, London.
Quarterly Journal of Pure and Applied Mathematics, London.
*Quincy Herald, Quincy.

†Report of the British Association for the Advancement of Science, London.

*Review of Reviews, New York.

Revue Universelle des Mines, de la Métallurgie, etc., Paris.

*Sault Ste. Marie News, Sault Ste. Marie.

*Scribner's Magazine, New York.

*St. Andrew's Cross, New York.

*St. Clair Republican, St. Clair.

*St. Johns News, St. Johns.

†School of Mines Quarterly, New York.

†Science, New York.

Scientific American, New York.

†Scientific American Supplement, New York.

†Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, Vienna.

†Sitzungsberichte der königlich-preussischen Akademie der Wissenschaften zu Berlin.

*Soo Democrat, Sault Ste. Marie.

Stahl und Eisen, Düsseldorf.

*State Republican, Lansing.

*†Stone, Chicago.

†Techniker, New York.

†Transactions of the Academy of Science, St. Louis.

Transactions of the American Institute of Electrical Engineers, New York.

*†Transactions of the American Institute of Mining Engineers, New York.

†Transactions of the American Society of Civil Engineers, New York.

†Transactions of the American Society of Mechanical Engineers, New York.

†Transactions of the Connecticut Academy of Arts and Sciences, New Haven.

†Transactions of the Federated Institute of Mining Engineers, Newcastle-on-Tyne.

Transactions of the Manchester Geological Society, Manchester.

†Transactions of the Royal Society of Canada, Montreal.

*Vassar Times, Vassar.

†Verhandlungen der k. k. Geologischen Reichsanstalt, Vienna.

*Workman, Grand Rapids.

*Ypsilantian, Ypsilanti.

†Zeitschrift für analytische Chemie, Wiesbaden.

†Zeitschrift für anorganische Chemie, Leipzig.

†Zeitschrift für das Berg.-Hütten-und Salinenwesen, Berlin.

†Zeitschrift der deutschen geologischen Gesellschaft, Berlin.

†Zeitschrift für Krystallographie und Mineralogie, Leipzig.

†Zeitschrift für physikalische Chemie, Leipzig.

†Zeitschrift für praktische Geologie, Berlin.

TEXT BOOKS.

1893-1894.

FIRST YEAR.

College Algebra.—1891. G. A. Wentworth.
Ginn and Company, Boston.

Plane and Spherical Trigonometry.—1893. H. N. Wheeler.
Ginn and Company, Boston.

Logarithmic Tables.—1892. G. W. Jones.
G. W. Jones, Ithaca, N. Y.

Analytic Geometry.—1887. Last Edition. G. A. Wentworth.
Ginn and Company, Boston.

Elementary Treatise on Physics.—1893. 14th Edition.
Ganot, translated by Edmund Atkinson.
Wm. Wood and Company, New York.

Practical, Plane and Solid Geometry. Last Edition.
Henry Angel.
William Collins and Sons, Glasgow.

Manuscript Notes on General Chemistry.—1893.
George A. Koenig.

Manuscript Notes on Experimental Chemistry. 1893.
George A. Koenig.

Descriptive Mineralogy.—1892. Sixth Edition.
James D. Dana and Edward S. Dana.
John Wiley and Sons, New York.

Theory and Practice of Surveying.—1892. Tenth Edition.
J. B. Johnson.
John Wiley and Sons, New York.

Field Engineering.—1893. Sixteenth Edition.
William H. Searle.
John Wiley and Sons, New York.

SECOND YEAR.

Elements of the Calculus.—1891. James M. Taylor.
Ginn and Company, Boston.

Mechanics of Engineering. Irving P. Church.
(Sixth Edition of Statics and Dynamics.)
Wiley and Sons, New York.

Qualitative Analysis.—1893. Arthur H. Elliot.
Arthur H. Elliot, New York.

South Kensington Notes on Building Construction. 1889.
Vol. 3. Rivington, London.

Elements of Mechanism.—1888. Second Edition.
T. M. Goodeve.
Longmans, Green and Company, London.

Steel and Iron.—1892. Fifth Edition.
Wm. Henry Greenwood.
Cassell and Company, London.

The Determination of Rock-Forming Minerals. 1891.
Second Edition.
Dr. Eugene Hussak, Translated by Erastus G. Smith.
. John Wiley and Sons, New York.

Text Book of Geology.—1893. Third Edition.
Archibald Geikie.
Macmillan and Company, New York.

Manuscript Notes in Lithology. 1892–1893.
M. E. Wadsworth.

THIRD YEAR.

Quantitative Analysis. Dr. C. Remigius Fresenius.
John Wiley and Sons.

Modern American Methods of Copper Smelting.—1892.
Edward D. Peters.
Scientific Publishing Company, New York.

Metallurgy of Lead.—1892. H. O. Hofman.
Scientific Publishing Company, New York.

Manual of Assaying.—1892. Walter Lee Brown.
E. H. Sargent and Company, Chicago.

Manual of Assaying.—1889.
Bodeman and Kerl, translated by W. Goodyear.
John Wiley and Sons, New York.

Hydraulics.—1890. Mansfield Merriman.
John Wiley and Sons, New York.

Trusses and Arches. Part I.—1892. Third Edition.
Charles E. Greene.
John Wiley and Sons, New York.

Electrical Engineering.—1891. Slingo and Brooker.
Longmans, Green and Company, London.

The Steam Engine. 1893. Fifth Edition. G.C.V.Holmes.
Longmans, Green and Company, London.

Mechanics of Materials.—1893. Second Edition.
Mansfield Merriman.
John Wiley and Sons, New York.

Elements of Geology.—1892. Third Edition.
Joseph LeConte.
D. Appleton and Company, New York.

The Ore Deposits of the United States.—1893.
James F. Kemp.
Scientific Publishing Company, New York.

SAMPLE EXAMINATION QUESTIONS FOR ADMISSION TO THE MINING SCHOOL.

ARITHMETIC.

1. (1). Draw a line a decimeter long and divide it into centimeters.

(2). What is the fundamental unit of length in the metric system.

2. (1). Describe the units of capacity and of weight in the metric system.

(2). Draw a cubic centimeter; a cubic decimeter.

3. (1). Multiply $\frac{3}{4}$ by $\frac{1}{2}$ and explain the process.

(2). Divide $\frac{7}{8}$ by $\frac{5}{16}$ and explain the process.

4. Change the common fractions to decimals in question 3, and perform the operations there required.

5. (1). B lost 5 per cent by selling a hektoliter of turpentine, which cost $15. For what did he sell it a liter?

(2). If A buys copper for 30 cents per kilogram, and on selling it makes 40 per cent on the cost, after deducting 10 per cent from his asking price, what was the asking price?

6. (1). Having sold a consignment of goods on 3 per cent commission, the agent was instructed to invest the proceeds, after deducting his commission of 3 per cent. His whole commission was $265. What amount did he invest?

(2). If copper stock pays 8 per cent on the par value, at what price must it be purchased to pay 10 per cent on the cost?

7. (1). What is the interest of $16,941.20 for 1 yr. 7 mo. and 28 days, at $4\frac{3}{4}$ per cent?

(2). What sum of money, invested at 6½ per cent, will produce $279,815.00 in 1 yr. and 6 mo.?

8. (1). A ship's chronometer, set at Greenwich, points to 5 h. 40 min. 20 sec. P. M. when the sun is on the meridian; what is the ship's longitude?

(2). A steamer arrived at Halifax, 63° 36′ west at 4 h. 30 min. P. M.; the fact is telegraphed to New York without loss of time. The longitude of New York being 74° 1′ west, what is the time of the receipt of the telegram?

9. Extract the square root of 58.140625, of .0000316969.

10. Extract the cube root of 10460353203, of .000148877.

ALGEBRA.

1. (a) Multiply $x^6 + x^5y - x^3y^3 + xy^5 + y^6$ by $x^2 - xy + y^2$.

(b) Divide $y^8 - 2b^4y^4 + b^8$ by $y^3 + by^2 + b^2y + b^3$.

2. Resolve into its factors $16x^4 - 81y^8$, also $a^6 - 1$, also $x^4 + x^2y^2 + y^4$, also $y^3 + y^2 - y + 1$.

3. (a) Simplify $\frac{x}{(x-y)(x-z)} + \frac{y}{(y-z)(y-x)} + \frac{z}{(z-x)(z-y)}$

(b) Simplify $\left(\frac{x^4-y^4}{x^2-y^2} \div \frac{x+y}{x^2-xy}\right) \div \left(\frac{x^2+y^2}{x-y} \div \frac{x+y}{xy-y^2}\right)$

4. (a) Multiply $x^2 + xy^{-1} + y^{-2} + x^{-1}y^{-3}$ by $x^{-1} - y^{-1}$.

(b) Simplify $\left[(a^m)^{m-\frac{1}{m}}\right]^{\frac{1}{m+1}}$ also $\left(\frac{x^{p+q}}{x^q}\right)^p \left(\frac{x^q}{x^{q-p}}\right)^{p-q}$

5. (a) Extract the square root of $30 + 12\sqrt{6}$.

(b) Solve $\frac{y-5}{2} - \frac{y-3}{4} + \frac{y+3}{5} - \frac{y+5}{6} = 0$, and explain the transformations necessary for the solution.

6. (a Simplify $\sqrt{\frac{a^4c}{b^3}}-\sqrt{\frac{a^2c^3}{bd^2}}-\sqrt{\frac{a^2cd^4}{bm^2}}$

(b) Simplify $\left(\frac{10\sqrt[3]{a^2}}{\sqrt[4]{5b^{11}}}\right)\left(\frac{5a\sqrt[3]{a^2}}{4b\sqrt[5]{a^2}}\right)$

7. (a) Solve $x^2+px+q=0$, and give the conditions under which the roots are real and *unequal*, real and *equal*, and imaginary; also when are they equal *numerically* with opposite signs.

(b) What is the sum of the two roots of the preceding equation? What is their product?

8. (a) Solve $\sqrt{x-3}+\sqrt{3x+4}\sqrt{x+2}=0$.

(b) Find the values of x and y in the independent, simultaneous equations $x+y=27$ and $x^3+y^3=5103$.

9. Find the 6th and the 15th terms of $(x-y)^{25}$, reducing the numerical results to their prime factors *and* not performing the multiplications.

10. (a) Prove that, if the corresponding items of two proportions be multiplied together or divided by each other, the result, in either case, is a proportion.

(b) If $a:b=x:y=z:q$, Prove that $a:b=\frac{x+z}{y+q}$.

PLANE GEOMETRY.

Demonstrate the following propositions:

1. The sum of the angles of any plane triangle is equal to two right angles.

2. Show that each angle of an equiangular pentagon is $\frac{6}{5}$ of a right angle.
3. In the same or in equal circles, angles at the center have the same ratio as their intercepted arcs. (Two cases.)
4. An inscribed angle is measured by one-half the intercepted arc. (Three cases.)
5. Two triangles are similar when an angle of the one is equal to an angle of the other, and the sides including these angles are proportional.
6. When a line is divided in extreme and mean ratio, the greater segment is one side of a regular decagon inscribed in a circle whose radius is the given line.
7. Similar polygons are to each other as the squares described on their homologous sides.
8. The square described upon the hypothenuse of a right triangle is equivalent to the sum of the squares described upon the other two sides.
9. (Problem). Given the perimeters of a regular inscribed and similar circumscribed polygon, to compute the perimeters of regular inscribed and circumscribed polygons of double the number of sides.
10. (Problem). To compute the ratio of the circumference of a circle to its diameter.

SOLID AND SPHERICAL GEOMETRY.

Demonstrate the following propositions:

1. If a straight line is perpendicular to each of two straight lines at their intersection, it is perpendicular to their plane.
2. If two triedral angles have the three face angles of the one equal, respectively, to the three face angles of the other, the corresponding diedral angles are equal.

3. **Two triangular pyramids having equivalent bases and equal altitudes are equivalent.**
4. **The frustum of a triangular pyramid is equivalent to the sum of three pyramids whose common altitude is the altitude of the frustum, and whose bases are the lower base, the upper base and a mean proportional between the bases of the frustum.**
5. In two polar triangles, each angle of one is measured by the supplement of the side lying opposite to it in the other.
6. The sum of the angles of a spherical triangle is greater than two and less than six right angles.
7. The area of a spherical triangle, expressed in spherical degrees, is numerically equal to the spherical excess of the triangle.
8. The area of a zone is equal to the product of its altitude by the circumference of a great circle.
9. (Problem). To find the volume of a spherical segment.
10. (Problem). To find the volume of that part of a sphere lying outside of a chord revolved parallel to its diameter and at a constant distance from it.

ELEMENTARY PHYSICS.

1. (1). Upon what property do most of the characteristic properties of matter depend.
   (2). Name three general and five characteristic properties of matter.

2. (1). Name and define the three states of matter.
   (2). Give Newton's laws of motion.

3. (1). Define work and energy; give the formula for the calculation of kinetic energy from weight and velocity.

(2). Give the laws of freely falling bodies.

4. (1). How prove that the atmosphere has weight?

(2). What is the object of experiments in the study of physics?

5. (1). Diagram, and explain the operation of the hydrostatic press.

(2). Define specific gravity and describe the experiments necessary to determine the specific gravity of an irregular solid. If the specific gravity of copper is 8.9 what is the volume in cubic centimeters, of a mass of this metal which weighs 3.2 kilograms?

6. (1). What is the mechanical equivalent of heat? To what is the heat of a body due? Do the atoms or the molecules of a body set either themselves or one another in motion?

(2). Give your idea of force. What is sound? What are the properties of a musical note? Diagram and explain the phonograph and the telephone.

7. (1). Explain the ways in which heat may be transmitted. Give some of its principal sources and effects. Change − 40 F., to C. Upon what does the boiling point depend?

(2). Define light. What constitutes the difference between light and heat? Between the different colors? What is the velocity of light? Of sound in the air, at the temperature 0 C?

8. (1). Give the laws of magnets. Give the laws of currents of electricity. Explain Ampère's theory of the magnet. How may magnets be made?

(2). Describe the experiments and the results obtained by the use of a galvanometer, a primary coil, a secondary coil, a battery and a magnet. Tabulate the results.

9. (1) Give Ohm's law. Define ohm, volt, ampère. Draw diagrams showing how to connect cells in series and in multiple arc or abreast. If a Bunsen cell has an electromotive force of 1.8 volts and internal resistance of .9 ohm, show how to connect ten such cells to get the greatest current, the external resistance being 100 ohms.

(2). Give some of the principal uses of electric currents.

10. (1). What constitutes the difference between the operation of a dynamo and that of an electro-motor?

(2) In charging a storage battery, what is stored up in it? What is meant by "the conservation of energy"?

ASTRONOMY.

1. What is the general structure of the *Solar System*, and what is the physical constitution of the *sun and* its surroundings?
2. What are the physical constitution and special characteristics of the inner group of planets, including the moon?
3. What are the physical constitution and characteristics of the outer group of planets?
4. What are the aspects, forms and physical constitution of the comets, meteors and shooting stars?
5. What are nebulæ; new, variable and double stars, and upon what evidences are the views concerning them based?
6. How are stars located in the heavens? What are the declination, right ascension, hour angle, latitude, longitude; and what are the six parts of the Polar triangle?

7. Describe the four kinds of time and give the maximum variations between them. How is the longitude of a place determined?
8. What is the general structure of the universe?
9. State clearly the Nebular Hypothesis, and give the evidence upon which it is based?
10. Give the general phenomena of the tides, their causes and laws.

BOOK-KEEPING.

1. Explain the use of day-book, journal and ledger, and state the rules for entering transactions in them.
2. What is a trial balance, and what is the process of making one?
3. Is a trial balance an absolute check? State reasons for your answer.
4. State the rules for crediting and debiting bills payable and bills receivable.

In addition to questions of the above character, a record of supposed transactions is given to the candidate to enter in the proper manner in the different books, and he is required to make his own rulings.

BUILDINGS.

Science Hall, or the main building now occupied by the Mining School, was completed by the State in 1889, at a cost of $75,000. The building is constructed of Portage Entry sandstone, with a tile roof (see Frontispiece).

The larger part of the site and grounds was donated to the School by the Honorable Jay A. Hubbell, to whom the establishment of the School is chiefly due. The building has a large and independent supply of spring water, sufficient for all its present needs.

The main building is 109 feet by 53 feet, with a wing 37 feet by 25 feet. The interior portion of the building has been arranged so as to save the greatest amount of space possible for the laboratories and working rooms, consistent with safety to the structure and proper light. The halls have been reduced to a minimum. The plans of the four floors are appended: The basement floor is used for a Boiler Room, Weighing Room, Metal and Wood-Working Shops and Assaying Laboratory. The first floor contains the Director's Room, Reading Room, Library, and Laboratories of General and Economic Geology, Petrography and Mineralogy. On the second floor are situated the Mathematical and other Recitation Rooms, together with the Laboratories for Physics, Drawing, Surveying and Mining Engineering. The third floor is devoted to the Chemical Laboratories, Chemical Lecture Room, Chemical Supply Room, Balance Room, etc.

Engineering Hall will be ready for occupancy in August, 1894. This building was provided for by the Legislature of 1893, and it will contain the following rooms:

BASEMENT.

Machine shop	97x24 feet.
Engine Room	34x17 feet.
Electrical Laboratory	34x27 feet.
Lavatory	28x10 feet.

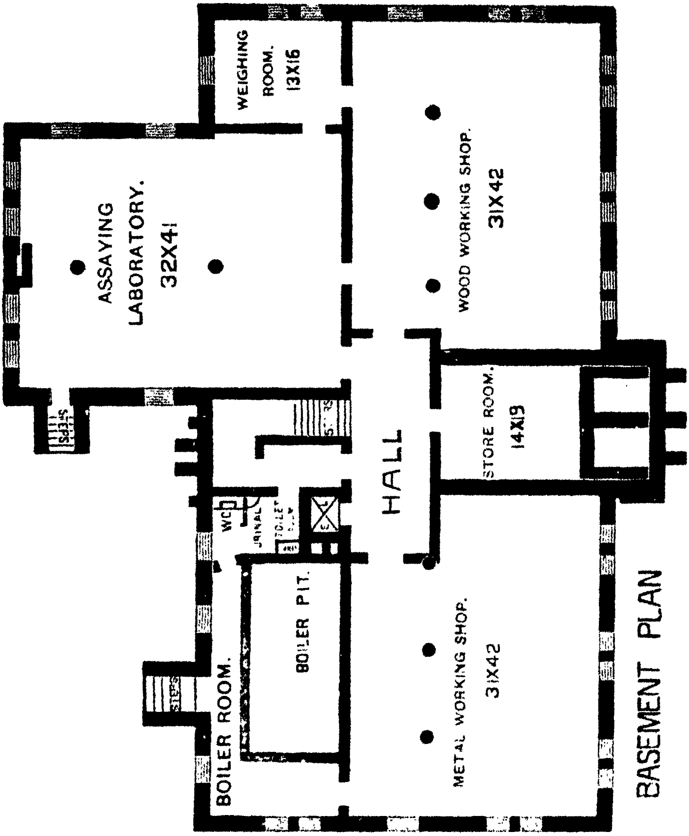
FIRST FLOOR.

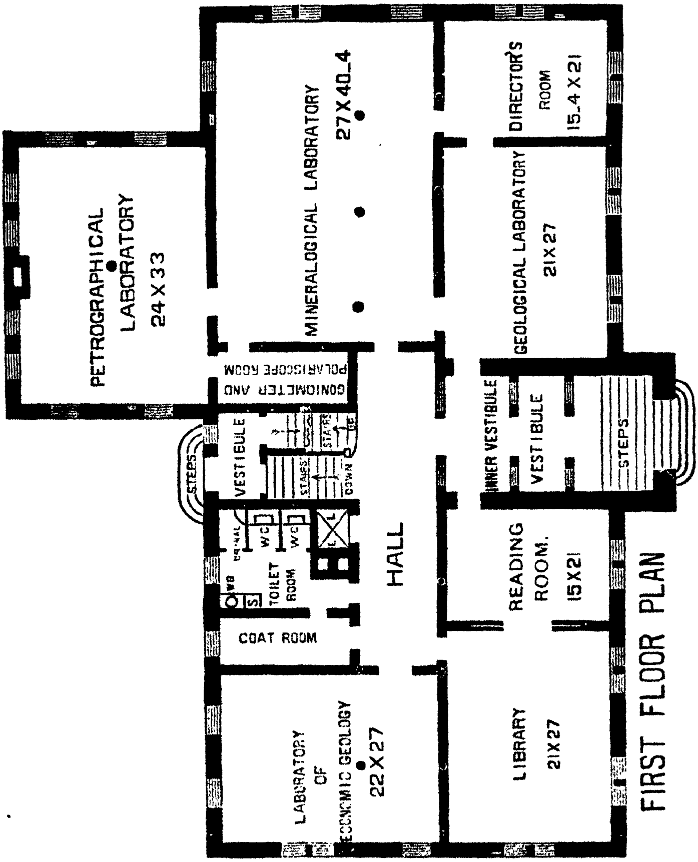
Pattern Shop	97x25 feet.
Lecture Room	28x26 feet.
Professor's Office	18x9 feet.
Tool Room	11x8 feet.
Lavatory	12x12 feet.
Paint Shop	16x13 feet.
Model Room	18x9 feet.
Storage Battery Room	15x11 feet.

SECOND FLOOR.

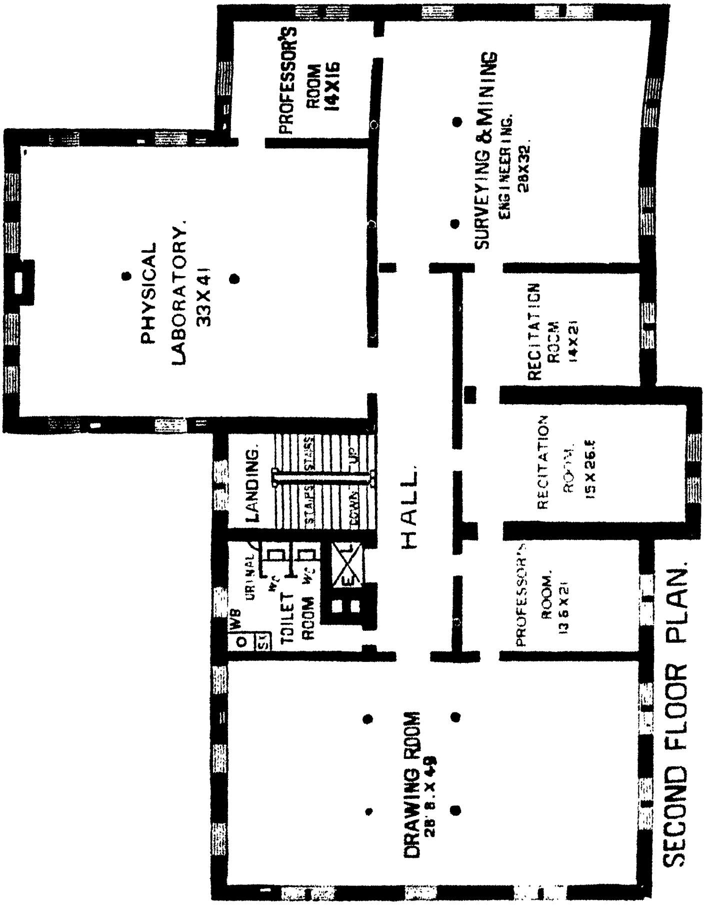
Drawing Room	97x25 feet.
Blue Print Room	12x8 feet.
Lecture Room	35x28 feet.
Assistant's Office	12x11 feet.
Office of Mining Department	16x15 feet.
Map Room	15x12 feet.
Lavatory	11x11 feet.

An annex contains a Fuel Room 16x34 feet, and a Boiler Room 29x34 feet. In the latter will be located three boilers, two of which are to be used for heating purposes. To enable the student to become practically familiar with water tube boilers, a 58 HP Stirling water tube boiler will be used to supply steam to shop and laboratory engine.

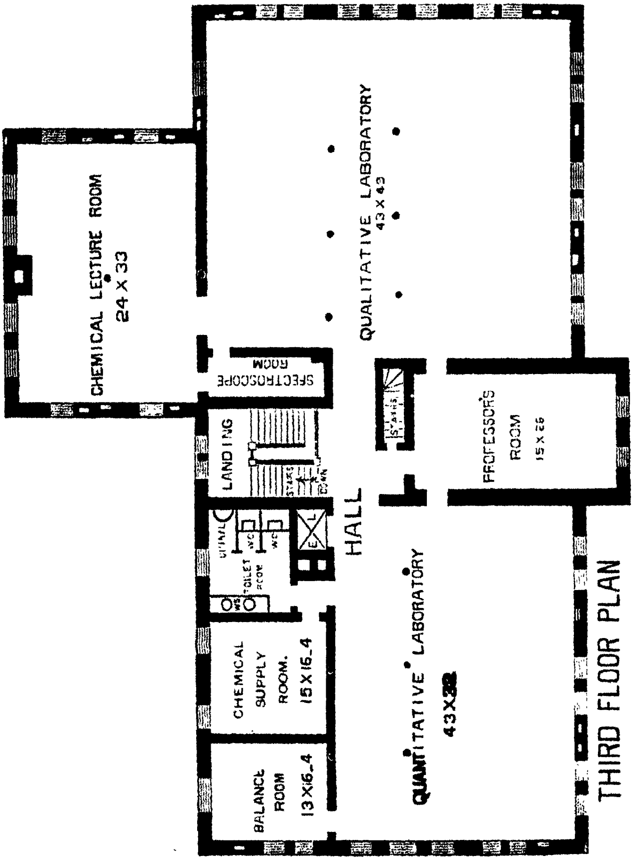

WEIGHING ROOM. 13X16
ASSAYING LABORATORY. 32X41
WOOD WORKING SHOP. 31X42
STEPS
STAIRS
HALL
STORE ROOM. 14X19
WC
URINAL
TOILET
BOILER PIT.
BOILER ROOM.
STEPS
METAL WORKING SHOP. 31X42
BASEMENT PLAN



FIRST FLOOR PLAN



SECOND FLOOR PLAN.



THIRD FLOOR PLAN

LOCATION.

The School is located in the village of Houghton (Portage Township), the county seat of Houghton county. The twin villages of Houghton and Hancock lie in the sheltered valley of Portage Lake, an arm of Lake Superior. The climate is bracing and healthful. Although Houghton is in a high latitude, yet one is far less inconvenienced by the cold here than he is much further south along the Atlantic coast, or in the immediate vicinity of the Great Lakes. This is due to the dryness of the Houghton climate, a climate which is free from any malaria, hay fever, etc. In general, students coming from localities further south have found health and strength improved by the change. The town has an abundant supply of pure spring water. Houghton is easily reached by rail from Detroit, Chicago, Milwaukee, St. Paul, Superior and Duluth; and by steamer from all the important ports on the chain of the Great Lakes. Within the State, half fare rates are given to the students of the Mining School by the Duluth, South Shore & Atlantic Railway and its associated railroads.

In answer to various questions asked, some of the routes are here designated: From Detroit one travels by the Michigan Central Railway to Mackinaw City, via Bay City. At Mackinaw City the cars of the Duluth, South Shore & Atlantic Railway are taken direct to Houghton. Time from Detroit about twenty-four hours. From Sault Ste. Marie, the Duluth, South Shore & Atlantic Railway carries its passengers direct to Houghton, time about thirteen hours. The same railway is taken from Duluth and Superior to reach the Mining School. Passengers from

Chicago and Milwaukee take either the Chicago, Milwaukee & St. Paul Railway, via Champion; or the Chicago & Northwestern Railway, via Negaunee and Ishpeming; at which places, on both routes, the passengers transfer to the Duluth, South Shore & Atlantic Railway for Houghton. Time from Chicago to Houghton, about seventeen hours.

Students desiring to reach Houghton by boat, can take steamers of the Lake Michigan and Lake Superior Transportation Company, at Chicago or Milwaukee, taking about three days from Chicago. From Buffalo, Cleveland and Detroit, one can take the steamers of The Western Transit Company, and The Erie and Western Transportation Company. Time from Buffalo about five days, Cleveland four days, and Detroit three days.

Any of these lines can be taken from Duluth.

Special information, descriptive pamphlets, time tables and rates can be obtained from the General Passenger Agents of the various companies by writing to their respective offices, as follows:

Duluth, South Shore & Atlantic Railway, Marquette, Michigan.

Michigan Central Railway, Monadnock Block, Chicago, Ill.

Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

Chicago & Northwestern Railway, Chicago, Ill.

The Lake Michigan & Lake Superior Transportation Co., Rush and North Water Streets, Chicago, Ill.

The Western Transit Co., No. 47 Main Street, Buffalo, N. Y.

The Erie & Western Transportation Co., Atlantic Dock, Buffalo, N. Y.

* * *

Houghton County is the third wealthiest county in Michigan, being surpassed only by Wayne (Detroit) and Kent (Grand Rapids) Counties. The population of the county, with its various townships and villages, is here given according to the latest returns.

The official census returns for Houghton County, as approved by the Board of Supervisors, are as follows:

		1890.	1894.
Adams Township			1,675
Calumet	"	12,529	16,709
Chassell	"	680	993
Duncan	"	680	984
Franklin	"	2,687	2,685
Hancock	"	2,737	4,345
Laird	"	159	231
Osceola	"	3,630	4,712
Portage	"	3,531	3,447
Quincy	"	1,490	1,490
Schoolcraft	"	3,325	3,908
Torch Lake	"	2,904	3,055
	Total	35,089	45,398
			35,089
	Increase in 3 years		10,309

The population of the villages is as follows:

	1894.
Atlantic Mine	1,675
Calumet	2,192
Chassell	551
Crystal Lake	55
Gregoryville	320
Hancock	1,662
Houghton	2,178
Kenton	113
Kitchie	75
Lake Linden	2,443
Mills' Station	794
Osceola	1,514
Oskar	171
Perkinsville	520
Quincy Mill	151
Quincy Mine	1,490
Red Jacket	3,242
Sidnaw	344
Tamarack and North Tamarack	1,402
Withey	184

The accompanying map (facing page 200) will give a fair idea to the prospective student of the location of the Mining School and the adjacent mines.

While the School itself is situated in the Portage Lake copper district, the access to the Keweenawan copper district on the north is easy; and there lie within comparatively short distances the Ontonagon copper district, and the iron mining regions of Marquette, Menominee and Gogebic.

In the immediate vicinity of the Mining School are located the Quincy, Atlantic, Franklin and Huron copper mines; while within a distance of fifteen miles are situated the Calumet and Hecla, Tamarack, Osceola and other copper mines, with their machine shops, smelting works, rolling and stamp mills, etc. In the iron mining region lie numerous great mines, prominent among which are the Cleveland, Jackson, Lake Superior, Lake Angeline, Champion, Republic, Chapin, Vulcan, Cyclops, Colby and Norrie.

In addition to copper and iron, among the mineral products of the state are numbered gold, silver, gypsum, building stones, slate, coal, salt, etc.

Some idea of the vastness of the mining operations in the Lake Superior district in Michigan alone, can be gathered from the following statistics: Its copper mines have produced, up to 1890, one billion seven hundred and sixty-four million five hundred and twenty-six thousand five hundred and thirty-nine pounds of copper. One mine alone has paid over forty millions of dollars in dividends.

In the iron mining districts about Lake Superior, in Michigan, there were produced in 1892 seven million five hundred and forty-three thousand five hundred and forty-four tons of iron ore, or nearly one-half of all the iron ore produced in the United States.

The Michigan iron mines have produced since their discovery over sixty-eight million tons of iron ore.

Michigan is credited with producing, in 1892, gold and silver amounting to one hundred and forty-five thousand dollars.

The State of Michigan is also the chief producer of gypsum in the United States; and in its salt production is second to New York only. It produced in 1892 one hundred and thirty-nine thousand five hundred and fifty-seven tons of gypsum; and during the same year, three million eight hundred and twelve thousand and fifty-four barrels of salt. Its coal product was in 1893, one hundred and four thousand six hundred and twenty tons.

The Michigan Mining School has been located in the Upper Peninsula of Michigan for the same reason that a medical school should be in the vicinity of large hospitals, in order that it should be associated with the objects about which it treats.

From this location the student of the Michigan Mining School is placed in a mining atmosphere, in which all his surroundings and associations are in conformity with his present and future work. He is thus enabled to see in actual operation some of the most successful and extensive mining operations now conducted anywhere.

Some little idea of the work of a few of the numerous mines of the Lake Superior district can be gathered from the following statements. That for the Calumet and Hecla is taken from a report published in 1893, while for the others, the information is taken from personal letters sent to the Director of the Mining School, by the agents or other officers of the mines:

CALUMET AND HECLA MINING COMPANY.

"Beginning on the shore of Lake Superior, we have there the Lake Superior Water Works, Pump House, and Boiler House, containing one Worthington high pressure compound condensing pump with cylinders of 19¼ inches and 33⅝ by 24 inches, and plungers 9 by 24 inches. Two spare Worthington pumps with cylinders 10 by 18 inches, and two boilers 64 inches diameter by 17 feet long, of 300 horse power, and one locomotive boiler 54 inches diameter, of 100 horse power. When fully equipped, the capacity of these works will be 2,000,000 gallons a day. The water is taken from a pipe 18 inches in diameter, and extending 1200 feet into Lake Superior. It is pumped through a 12-inch wrought-iron pipe line 4½ miles in length, to an altitude of more than 700 feet, to the mine, where it is distributed over the whole location. * * * *

"The real estate of the Company consists of 2599 $\frac{25}{100}$ acres of mineral land in Houghton County, and 20,352 $\frac{85}{100}$ acres of timber lands in Keweenaw, Houghton, and Ontonagon Counties. At the Stamp Mill there are 988 $\frac{19}{100}$ acres.

"There are 698 houses belonging to the Company, of which 570 are on the mine location, 106 at the lake, and 22 at the Smelting Works. On leased lots, our men own 782 houses at the mine, and 159 at the lake.

"There are 20 churches on the property of the Company, the greater number of which have been materially assisted by the Company at some time in their history.

"There are, on land of the Company, six schools at the mine and lake, built partly at the cost of the Company and partly by the school district. The Company also owns a hotel.

"There are at the mine, for cutting sets of timber used underground, a timber building, a large machine shop 225 by 250 feet, with a full complement of tools. We have also at the mine three blacksmith's shops, two warehouses, * * * two carpenter shops, and a paint shop. * * * *

"The Calumet Engine House is a building of brick and stone, 146 by 62 feet. It contains: the compound engine 'Superior', with cylinders of 40 inches, and 70 by 72 inch stroke, of 4700 horse power; the Corliss engine 'Rockland', used as a spare, of 600 horse power; the Leavitt engine 'Baraga', 40 by 60 inches, also a spare, of 2000 horse power; one pair 32 by 48 inch Rand Compressors, with a capacity of 26 air drills; and one pair 36 by 60 inch Rand Compressors, with a capacity of 41 air drills. There are four drums 20 feet 6½ inches in diameter by 8 feet 4 inches face, to hoist from a depth of 4000 feet from shafts Nos. 2, 4 and 5 Calumet, and No. 3 Hecla. By winding over and not increasing the load we may reach 6000 feet.

"The Boiler House is of stone 77 by 60 feet. It contains five boilers, two of 84 inches in diameter by 35 feet long, made by Kendall and Roberts: three of 90 inches diameter by 34 feet 6⅝ inches long, made by the Dickson Manufacturing Company, the Southwark Foundry, and the I. P. Morris Company: total horse power, 2780. The stack is 5 feet 6 inches bore, and 150 feet high.

"The Hecla Engine House is a brick building 80 by 47 feet, with an ell 44 by 17 feet 5 inches, and contains the compound engine 'Frontenac', 27½ and 48 by 72 inches, of 2000 horse power; the Corliss engine 'La Salle', 30 by 72 inches, used as a spare, of 900 horse power: and the Corliss engine 'Perrot', 30 by 48 inches, also a spare engine, of 600 horse power: in addition, the two pair of compressors, water plunger type, 42 by 60 inches, with a capacity of 144 air drills, 72 drills for each set: one pair of Rand Compressors, 28 by 48 inches, of a capacity of 31 air drills.

"The Boiler House is of brick, 80 by 58 feet, and contains three boilers made by Kendall and Roberts, 84 inches by 32 feet 10⅝ inches, and two boilers made by the Dickson Manufacturing Co., 90 inches by 34 feet 4 inches, with a total of 1690 horse power. The brick stack is 4 feet 6 inches in diameter and 120 feet high.

"On the Hecla, another Hoisting Engine and Boiler House contains the triple expansion hoisting engines 'Gratiot', 'Houghton', and 'Seneca', of 2000 horse power each, having cylinders 18 and 27½ inches, and 48 by 90 inches, fitted with conical hoisting drums to reach a depth of 5500 feet. The engine house is of stone, 112 by 78 feet. The boiler house of the same material, is 76 by 68 feet. There are five boilers, of 505 horse power each, 90 inches in diameter by 34 feet 6 inches long, built by the Dickson Manufacturing Company, of Scranton, Penn., and the I. P. Morris Co., of Philadelphia, Penn. The brick stack is 9 feet 4 inches in diameter, and 200 feet high. * *

"The Engine House for Hecla shafts Nos. 7 and 8 contains the triple-expansion engines 'Hancock' and 'Pewabic', each of 2000 horse power; each operating by spur gearing its own drum, which is 25 feet in diameter by 8 feet 2¼ inches face, having a rope capacity of 5500 feet, of 1½ inch diameter. The cylinders are 20½ and 31¾ inches and 50 by 48 inches. The maximum speed is 92 revolutions per minute, which is 3¾ revolutions to one of the drums. The house is 122 feet long, and 50 feet wide: it is built of stone.

"The Boiler House will eventually hold ten boilers: it now contains three. They are 90 inches in diameter by 34 feet 6 inches long, and 505 horse power each. The house is 150 feet long and 65 feet wide. The stack is 12 feet 6 inches inside diameter, and 250 feet high.

"Shafts Nos. 9 and 10 Hecla, are operated from a Hoisting Engine House built of stone, 75 by 46 feet. It contains two compound hoisting-engines, the 'Detroit' and 'Onota', of 1000 horse power combined, having cylinders 18 and 32 by 48 inches stroke, built by George H. Corliss. These engines drive by spur gearing two hoisting drums, formerly located at the Superior Engine House, each 20 feet in diameter by 8 feet 4 inches face, and will wind 4000 feet of 1¼ inch rope. The drums make one revolution for every three revolutions of the engine.

"In the Hoisting Engine House operating shafts Nos. 11 and 12 Hecla, there is a pair of Woodruff and Beach engines built in 1869, of 20 inches diameter by 48 inches stroke, with two drums of 8 feet diameter and 6 feet face. As one of the man-shaft engines, we use a vertical engine 26 inches in diameter by 36 inch stroke, built in 1867. * * * *

"We have eight new shaft-rock houses, extending from Calumet No. 5 to Hecla No. 12, a total length on the surface of 9000 feet: the copper shute having in all a length of something over two miles underground, say 10,630 feet. There are eight shaft-rock houses at Hecla and at Calumet shafts, each containing a Westinghouse Driving engine of 60 horse power, and two 'Blake' crushers: each rock house with a bin capacity of about 1500 tons. Both at No. 5 Calumet and at No 4 Hecla, there is a fan for underground ventilation: these are 30 feet in diameter, with a capacity of about 100,000 cubic feet per minute. There are man-hoist buildings at five of the Hecla and three of the Calumet shafts; each contains a pair of engines and a drum, used only for taking men up and down. Twenty-eight men can ride on one of the cars; they are especially constructed for that use. Three of the houses contain each a pair of 20 by 30 inch engines, with drums to wind 4000 feet of 1¼ inch rope: the other five, one pair of engines 20 by 36 inches, with drums to wind 6000 feet of 1¼ inch rope.

"The Electric Light and Power House is built of stone, 74 by 74 feet; it contains a Porter-Allen engine, 18 inches in diameter by 36 inch stroke, of 400 horse power. A Westinghouse compound engine 23 and 40 by 20 inches, and 740 horse power, will be installed in this house.

"There are two electric light dynamos for 1000 sixteen candle power lights each: three Brush arc-light dynamos for 74 lights; five Brush generators 120 horse power each, with electric lines leading to the principal buildings, and to the three underground electric pumps at the Hecla end. Each pump has three double acting plungers 5¾ inches in diameter by 18 inch stroke, to run 50 revolutions per minute. At the Calumet end in No. 4 shaft, there are to be five electric pumps, each with three double acting plungers 5¾ inches in diameter by 18 inch stroke, to run 50 revolutions per minute. These pumps are placed 800 feet apart, having a vertical lift of 600 feet; the pump column is 8 inches in diameter. We have at Calumet Nos. 4 and 5 shafts two spare steam Worthington pumps, with cylinders 10 and 18 inches by 18 inches, of a capacity of over 500,000 gallons per 24 hours.

"The six-compartment Red Jacket Vertical Shaft has reached a depth of 3050 feet. It will intersect the Calumet lode at a depth of 3300 feet, and will reach the bottom of our territory at a depth of 5000 feet.

"It is equipped with a sinking-engine house of stone, 69 by 36 feet, containing a pair of horizontal tandem Corliss engines, with cylinders 16 and 32 inches in diameter by 48-inch stroke, with tail-rope house, and has the Whiting drum system.

"The main hoisting-engine house, built of stone, 220 by 70 feet, contains two pair of triple expansion engines, of 3000 horse power per pair, having cylinders 20½, 31⅝, and 50 inches in diameter by 72 inch stroke, to run 60 revolutions per minute, and fitted with the Whiting drum system, arranged to hoist ten tons per load, at a speed of 60 feet per second. The tail house for the fleet gear is 412 by 32 feet, and is placed on the north end of the engine house. The sheave house is placed at the south end; it is 43 by 32 feet. These engines are calculated to hoist from a maximum vertical depth of 5000 feet.

"The Boiler House is built of stone, 150 by 68 feet, and will contain ten boilers, each 90 inches in diameter by 34 feet 6 inches long, and adapted to a working pressure of 185 pounds, at which they will each furnish steam for 1000 horse power. There are at present six boilers in the house. The stack is of brick, 12½ feet inside diameter, and 250 feet high. * * * * *

"The water used by our condensing engine is supplied from the Calumet Pond Water Works, where we have a main pond of a capacity of 60,000,000 gallons, at five feet depth, and an auxiliary pond of a capacity of 30,000,000 gallons, at 2½ feet; both ponds are, when filled, of a capacity of say 100,000,000 gallons.

"The Water Works Building consists of an engine and boiler house of brick, 100 by 45 feet; it contains a Leavitt pumping engine, of a capacity of 5,000,000 gallons per day, steam cylinders 11¾ inches, and plungers 17 by 24 inches. In addition, there are two Worthington pumping-engines, of a capacity of 14,000,000 gallons per day; one pump with steam cylinders 14 and 24 by 36 inches, and 20 by 36 inch plungers, of a capacity of 4,000,000 gallons; and two others with steam cylinders 21 and 42 by 36 inches, and 29 by 36 inch plungers, of a capacity of 10,000,000 gallons.' The boiler house contains three boilers, Kendall & Roberts make, of 603 horse power, two of 54 inches by 26 feet 10 inches; and one of 84 inches by 35 feet. A pipe-line 16 and 24 inches in diameter, runs to the Superior Engine House, and from there north and south along the line of the lode.

"The length of all the shafts sunk below the average level of the stopes is over two miles, and the length of all the drifts run below the average level of the stopes is 13$\frac{6}{10}$ miles. * * * *

"At Torch Lake are located the Stamp Mills, the Calumet Mill containing eleven Leavitt heads with steam cylinders of 14 and 21¼ by 24 inches stroke, with a complete equipment of washers, Huntington and Haberle grinding-mills, and slime tables.

"As spare power, we have a Westinghouse driving-engine of 200 horse power. At the Hecla Stamp Mill we have made an addition of four heads, which gives us there now eleven Leavitt heads, with steam cylinders 14 and 21¼ by 24 inch stroke, and an equipment similar to that of the Calumet mill. We are also preparing to place solid anvils under all the stamps.

"The Stamp Mills and Water Works Boiler House contains eleven boilers, four of 80 inches diameter by 32 feet long, and seven of 90 inches diameter by 34 feet 6 inches long, made by Kendall & Roberts, the Dickson Manufacturing Company, the Southwark Foundry, and the I. P. Morris Co., aggregating 4730 horse power, commercial standard.

"The three boilers now running the pumping house, of 1515 horse power, will be removed to the main stamp-mill boiler house, which will be enlarged to accommodate twenty-two boilers. * * * *

"Torch Lake Water Works, which supply the Stamp Mills, consist of the triple-expansion pumping engine 'Michigan', of a capacity of 60,000,000 gallons daily, with the following engines as spare pumps: The compound pumping engine 'Erie', with a capacity of 10,000,000 gallons daily: the compound pumping engine 'Ontario', with a capacity of 20,000,000 gallons daily: the geared pumping engine 'Huron', with a capacity of 20,000,000 gallons daily.

"The compound driving engine 'Wabeek', 22¼ and 38 by 60 inch stroke, of 728 horse power, operates the washing machinery, the stamp steam-valve gear, and the sand wheels, by means of wire rope transmission. The stamped sand is distributed by four sand wheels: the Calumet 40-foot sand wheel, with a capacity of 18,000,000 gallons, and of 1,600 tons of sand; the Calumet 50-foot sand wheel, with a capacity of 30,000,000 gallons and of 3,000 tons of sand. As a spare engine for the Calumet wheel, we have a high-pressure engine 24 by 48 inch stroke, of 250 horse power. The Hecla 40- and 50-foot sand wheels have the same capacity as the Calumet sand wheels of the same dimensions. The spare engine for the Hecla wheels is a duplicate of the Calumet. * *

"The horse power of the boilers at the mine, commercial standard, is 13,765; the horse power of the boilers at the Lake Superior Water Works is 400; the horse power of the boilers at the Stamp Mills is 6,235; the horse power of the boilers now building is 2,022; and the total horse power, commercial standard, is 22,422. The aggregate horse power which can be developed by the engines belonging to the Company is 40,000.

"The Smelting Works at Torch Lake occupy nearly thirty acres; they are connected with the Stamp Mills by a short line of Railway, over which our mineral trains handle the daily product, which is there stored in the mineral houses

"The plant consists of four stone furnace buildings 80 by 130 feet each, with four furnaces, boshes, cranes, and all the ordinary equipment; one blister furnace building, of stone, 50 by 70 feet, with two furnaces; one cupola building containing two furnaces, with the necessary engines, blowers, and boilers; machinists' and blacksmiths' outfits, electric light plant, etc. Mineral building No. 1 has a bin capacity of 2,000 tons, and mineral building No 2 and its addition has a capacity of about 9,000 tons; and there are two wharves of a length of over 1,000 feet, with the necessary hoisting apparatus for coal and limestone."

Allouez Mining Company.

"The mine is opened by three shafts. No. 1 is about 1500 feet; No. 2, 1709 feet; and No. 3, 1200 feet, in depth. The bed or lode mined is the 'Allouez Conglomerate'. It has a thickness of from 18 to 28 feet. The copper rock usually makes in several layers from foot to hanging wall, with layers of barren rock between them. Two 'Knowles' pumps, operated with compressed air, and stationed at the 13th and 18th levels, No. 2 shaft, pump the water to the 7th level, where it flows through the level to No. 1 shaft, into a sump at the 8th level, and is from there forced to surface by a Gordon & Maxwell steam pump. The Mine equipment consists of two hoisting engines, capable of hoisting from 700 to 800 tons of rock per day. Two 'Rand Air Compressors', with a capacity for thirty-four No. 3 Rand Drilling Machines.

"The rockhouse is furnished with driving engine, two 18x24 inch, and three 9x15 inch Blake type rock crushers; also drop hammer for breaking the larger size of rock. Six fire box crown flue boilers, of about 100 hundred horse power each, furnish steam for all the mine plant. Machine, Blacksmith, and Carpenter shops are provided with the necessary tools to do all ordinary repair work.

"The Stamp Mill is situated about 2¼ miles to the north of the mine. It contains three 15-inch cylinder 'Balls' steam stamps, capable of crushing 500 tons rock per day. The crushed material is dressed by 'Collom' Jiggers. Steam is supplied by four 100 horse power boilers of the fire box crown flue type. Two locomotives are on hand, one of which ordinarily is used to transport the rock from the mine to the mill, over a three-foot gauge track, laid with 50 pound steel rails. The mine, when in full operation, employes about 300 men."

PITTSBURGH AND LAKE ANGELINE MINING COMPANY.

"The Lake Angeline mine workings are a little over 5,000 feet in length. The depth is 500 feet. There are four shafts: A, 450 feet deep; C, 500 feet deep; D, 350 feet deep; and E, 210 feet deep.

"There are eight boilers and mine engines; two Cornish plunger pumps, and four steam pumps. There are six hundred and fifty men employed, and the capacity of the mine is a little over five hundred thousand tons per year."

THE VOLUNTEER IRON COMPANY.

"The ore in the mine extends for about 2,500 feet in length, and the mine is about 600 feet deep. There are four shafts, A, B, C, and D. The capacity of the mine is about 300,000 tons per year. Three boilers; five engines."

WINTHROP IRON COMPANY.

"There are two shafts at the 'Mitchell', 'A' and 'D'. 'A' shaft is 555 feet deep, and the workings are about 350 feet long. 'D' shaft is 300 feet deep.

"A continuation of the 'Mitchell' to the west is the 'Winthrop', which is owned in fee by the Winthrop Iron Co. We had two shafts on the north side of the dioryte; No. 1, which is now owned by the Lake Superior Iron Co., being 420 feet deep, and No. 4, which is 560 feet deep. We have one other shaft on

Winthrop land, on the south side of the dioryte No. 2 shaft, which is 480 feet deep, and the workings are about 500 feet in length.

"We have in use ten boilers, two hoisting engines, one 18x30 Rand Compressor, and one 15x25x10x24 Duplex Worthington Pump, with which we handle all of our water from the mine."

SAGINAW IRON MINING CO.

"Depth of mine, 318 feet; length of mine, 120 feet; number of shafts, one; number of boilers, 72"x18', three; number of hoisting engines, one; number of air compressors, one; number of pumps, 14x12x10, three; number of Rand drills (No. 3) five; number of men employed, fifty-three."

ARAGON MINING COMPANY.

"This mine has produced, since mining was commenced in the latter part of 1889, until June, 1894, 530,314 tons of ore. We are mining three grades, viz: *Castile*, guaranteed to run 65½ per cent Iron and not above .010 P; *Aragon*, Fe 64, P .030; and *Granada*, Fe 64, P .125. The ore now produced is mostly non-bessemer.

"The ore deposit is very much folded and broken.

"The size of the productive area has increased from level to level, being 37,400 square feet at a depth of 500 feet. On the 7th level—650 feet deep—which is still undeveloped, we have now 34,400 square feet of ore.

"The ore is hoisted through one incline shaft, equipped with skips, and one vertical cage shaft. The hoisting engines are of the portable type, having five and six foot drums respectively.

"Compressed air is furnished to 30 Rand drills, by one 18x30 inch duplex Rand compressor, and one 14x16 compound Norwalk compressor. A 15x25x10x24 compound condensing Worthington pump lifts 500 gallons water per minute, from the 500 feet level to the surface. The bottom level is unwatered by two No. 10 Cameron pumps, throwing water from the 650 to the 500 feet level. The surface water, from the swamps overlaying the mine, is taken care of by low-service Cameron pumps.

"There are eight horizontal return tubular boilers, and one vertical tubular, of a combined capacity of 960 horse power.

"300 men are employed, producing 15,000 tons per month."

MASTODON IRON COMPANY.

"Depth of main shaft, 400 feet (2 cages); length of mine, 250 feet. Two boilers, 6x18 feet. Open pit has skip road and

Rochester double hoisting engine, 10x14. Hoisting engine of Marinette manufacture. 18x24-inch cylinder. Two six-foot drums. Two No. 10 Cameron pumps, only one being in use at a time. Number of men employed, about fifty. One Merritt Duplex Air Compressor, 12x24. Three Rand drills: two No. 2, one No. 3. One Diamond drill outfit. Width of ore deposit, 75 feet."

ASHLAND IRON MINING CO.

"The Ashland has six working shafts, of depth and length as follows, respectively:

Shaft No.	3	4	5	6	7	8
Length..........	926	941	862	935	999	940
Depth....	843	859	778	818	909	819

"Boilers: Seven return tubular, 600 horse power capacity; two Stirling water tube, 300 horse power capacity.

"Hoisting Engines: One Webster, Camp & Lane hoisting plant, duplex, cylinders 26½x48, Brown cut off, five drums 10 feet diameter. One Marinette hoist, 18x24, two drums 6 feet diameter. Several small hoists.

"One Ingersoll-Sergeant Duplex Air Compressor, 18x30; engines are Cooper Corliss, with No. 7 Worthington Independent Condenser; rated capacity, 25 drills. Two Ingersoll-Sergeant Right Line Air Compressors, 20x24, Myers' cut off; capacity of each, 12 drills. One Cornish Pumping Plant E. P. Allis, Corliss Engine, 22x48 inch, two plungers, 14 inches; 9 ft. stroke.

"Electric Light Plant: Two U. S. dynamos; capacity, 300 incandescent lamps 16 c. p., 110 volts. Two Westinghouse Junior engines 9x8, 35 horse power each.

"One Worthington Duplex Compound Plunger Pump, 15x25x9½x24 inches; capacity, 700 gallons under pressure of 300 lbs. per square inch. Eighteen Cameron pumps, sizes No. 7 to No. 10.

"Machine Shop has: One Blaisdell Engine Lathe, 26" swing, 14' long; one Bickford Drill Press, 38" table; one Gray Planer 30x30", 8' table; one Curtis & Curtis pipe machine, 2½ to 6 inches.

"One Bucyrus Steam Shovel.

"Mine working capacity, 400 men. Have mined and shipped since 1883, 1,700,000 tons of ore, of average analysis, 63.5 Fe, .044 Phos.

BROTHERTON IRON MINING COMPANY.

"There are three working shafts at a depth of 400 feet; two hoisting engines; four boilers; and six No. 10 Cameron pumps.

Two hundred and ten men employed. The annual output is about 120,000 tons of ore."

NEWPORT MINING COMPANY.

"Location comprises N. ½ of Section 24, Twp. 47 N., Range 47 W.

"On N. W. ¼ are four producing shafts as follows: No. 4, on North Vein; depth 359 feet. 'A', on South Vein footwall; depth 473 feet. 'B', on South Vein footwall; depth 517 feet. 'C", on South Vein footwall; depth 430 feet.

"The pumps in these shafts are as follows: 'A', No. 5 Cameron pump. 'B', No. 5 Cameron pump. 'C", No. 5 Cameron pump. 'C", No. 9 Cameron pump.

"The No. 5 pumps all pump up to the No. 9, which throws all the water from these shafts to surface. These shafts are all connected, and are about 400 feet apart. C. is also connected with them by a cross cut.

"The power house on this location has one tubular boiler, 72"x16'; one tubular boiler 60"x16'; and one Sterling Boiler. One Bullock Corliss Engine of 150 horse power; and one Webster, Camp & Lane Engine of about 100 horse power; and four 6-foot drums for hoisting.

"On the N.E. ¼ is one producing shaft, 504 feet deep, called "K", not connected with any other shaft, and is on footwall. Pumps in this shaft: One No. 10 Cameron special; one No. 10 Cameron.

"The power house on this location has one tubular boiler 72"x16'; two tubular boilers 48"x16'; and one Marinette engine, double, of about 50 horse power, with a 6-foot drum. Boilers are all return tubular, except Sterling.

"Shafts are all measured for depth on inclination of footwall, which makes an angle of about 65 ° with the horizontal.

"Number of men employed varies. When all the shafts are running, about 250."

GREAT WESTERN MINE.

"Our workings are 760 feet long, reached by two shafts, 585 and 550 feet deep respectively, at the present time.

"The mine is equipped with: One 100 horse power Hoisting Engine, with three 7-foot drums; one 80 horse power Hoisting Engine, with two 4-foot drums; one 8x10 Duplex Hoisting Engine, with two 4-foot drums; one 12x36 in. Duplex Air Compressor; twenty-one No. 2 Rand Rock Drills; three No. 3 Rand Rock

Drills; two 100 horse power Steel Boilers; two 80 horse power Steel Boilers; one 60 horse power Steel Boiler. Machine Shop fully equipped.

"We employ about two hundred men."

ROPES GOLD & SILVER COMPANY.

"Our shaft No. 1 (or Curry) is 800 feet deep; No. 2 (or Ely) shaft is 100 feet in depth. Are using three boilers, three engines, eight pumps, forty stamps, twelve vanners; and employing forty men."

EMPLOYMENT.

The question is often asked, if the Mining School can promise employment to students, on graduation. The only answer is, that neither the Mining School nor any other self-respecting institution can make any such promises. The question of employment depends on too many factors to be promised three or four years in advance. It depends on the demand and the supply, which are liable to vary from year to year; and it also very largely depends on a student's personal "equation". Prior to 1893, the demand for suitable men was greater than the supply; and such will be the case again, on the revival of business. People are prone to forget the general laws of Political Economy, as shown in periods of prosperity, and in business depressions and panics. The student is apt to think that because at any one time there is a depression in the profession he is proposing to follow, that therefore there is no future in it; overlooking the fact that such depressions are shown by history to be incident to every occupation, and that prosperity follows stagnation as surely as the latter will succeed a period of marked business activity. The cycle may be formulated as, "a state of quiescence, next improvement, growing confidence, - prosperity, excitement, over-trading, - convulsion, - pressure, - stagnation, distress, - ending again in quiescence", when the cycle is again repeated. Thus it follows, that a pupil entering upon his preparation for his future occupation in a time of prosperity is less sure of employment on graduation than one who starts upon this preparation during a time of distress.

The following table taken from Thom's Edition of

Juglar's "Brief History of Panics", will indicate that these periods of depression are not confined to any one country or business, but are widespread, if not universal—and are dependent upon some general periodic law:

DATE OF COMMERCIAL CRISES.

FRANCE.	ENGLAND.	UNITED STATES.
1804	1803	....
1810	1810	....
1813 14	1815	1814
1818	1818	1818
1825	1825	1826
1830	1830	1829 31
1836 39	1836 39	1837 39
1847	1847	1848
1857	1857	1857
1864	1864 66	1864
....	1873	1873
1882	1882	1884
1893	1890 91	1893

The periodic time is variable, but latterly it appears to be from eight to ten years in length, roughly divided as follows: "Prosperity, for five to seven years; panic, a few months to a few years; and liquidation about a few years". The past three panics have been followed by strikes in 1877, 1885-86 and 1894, that greatly retarded the advancing tide of prosperity. The signs of the times, are that already the current has changed, and that in from one to three years business activity will be the rule, and our mineral industries will prove no exception. The natural law is to prepare in dull times to take advantage of the active years, and this applies to mining as well as to all other occupations.

The success of a graduate depends very much upon himself, and it will be evident from the positions now occupied by the class that graduated during the panic of 1893, that who went out and searched for employment found it.

A thorough, hard working student, with the ability to command the respect of men and to manage them, and to work harmoniously with his fellow officers, will hardly ever fail of obtaining the choicest positions that are open to him; especially after having had the practical work and experience about the mines that the graduates of this school have.

Education and training do not give qualities to any man; they simply sharpen and develop those natural abilities that he possesses; hence, if he is not by nature fitted for a certain position, he ought not, and will not be likely, to obtain it. On the other hand, whatever may be a man's natural abilities, he will not be likely to obtain a position of any high grade unless he has been educated for it, either in school or outside—the outside education being by far the most expensive kind of education that can be obtained.

Slothful, lazy, careless, and inefficient students will not, naturally, obtain places as readily as the hard-working ones, other things being equal. They certainly will not be recommended as different from what they are by the Director of the Mining School; since a man who cannot be trusted to attend faithfully to his work when engaged in obtaining his professional training is not one whom it is safe to trust with important business and mining interests.

Students should remember that their conduct, from the day they enter the Mining School until they leave it, has an all important bearing upon their future position and standing.

The Director of the Mining School makes one invariable rule, *i. e.*, that all persons desiring students or graduates *of this School shall be informed of the defects, as well as of the virtues, of the candidates, so far as he knows them; believing that such a course is the only one that is just* either to the employer, to the student, or to the school. When information is fully given concerning the position and desired qualities of the person to fill it, pains are taken to select the student who is believed to be most suitable for the position.

In order to secure the best future for themselves, students are urged to neglect no opportunities, even beyond those afforded by the School, to inform themselves in the practical work of mining.

The graduates are also urged to turn their attention to a field in which success is almost sure, to men of ability and energy; to enter the mines or works as miners, foremen, or in some other subordinate capacity, and thoroughly master every detail, from the lowest to the highest work, since only men who have had this experience are apt to obtain the highest positions.

It is men who have had a thorough education, both in the theoretical and practical mining, and who have worked in every grade of work, that are even now sought to take charge of our mines and their allied industries. The future is for the man who is modest and willing to commence at the bottom of his profession, and who is conscious of the truth, that on graduation he is only just prepared to begin his work.

The graduates of the school are urged to keep the Director constantly informed concerning their positions, salaries, etc., and also what their desires are, in order that they may be assisted to advance, if opportunity offers.

Officers of mines, and others, desiring surveyors, engineers, draughtsmen, foremen, chemists, assayers, etc., are requested to make their wants fully known to the Director of the Mining School, who will then recommend suitable candidates to them, if he knows of any.

The inquiry is frequently made by persons intending to become students, if they can attend to their school work and earn enough to pay their way at the same time. Such a course is not practicable, as the regular school work, if it is done as it should be, requires the entire available time of any student, however strong and able he may be. As a special student, taking only a few studies, one might be able to procure sufficient work to pay one's way. The better way for the needy student is either to attend to his school and to his labor in alternate years, or else to borrow the means to continue his education, repaying through his increased earning power after graduation.

The salaries obtained upon graduation have been from $500.00 to $1,800.00, averaging about $900.00 per year. The lower salaries were obtained by students who had less practical experience with men and with the world in general; these were obliged to spend some time in acquiring a special kind of knowledge that the Mining School cannot give.

So far as known, the salaries have increased, after a varied time from $900.00 to even $2,000.00 or more per year, averaging about $1,200. All this, however, is dependent upon the demand and supply, the state of the mining industries at any time, as well as upon other factors too numerous to be mentioned.

The Mining School has several positions that are expected to be open every year, paying various sums up to $500.00, that are available for students of a suitable grade to give a certain amount of instruction, and to pursue their studies in certain lines. For graduates and others who have a taste for such work, it opens an excellent opportunity for study and self discipline preparatory to their future occupation.

CALENDAR.

1894–1897.

SUMMER TERM commences Monday morning, April 23, and ends Friday evening, August 17, 1894.

Field Work in Surveying commences Monday morning, June 4, and ends Wednesday evening, August 15, 1894.

Shop Practice begins Monday morning, June 11, and ends Wednesday evening, August 15, 1894.

Practical Work in Assaying begins Monday morning, May 28, and ends Friday evening, June 8, 1894.

Practical Work in Ore Dressing begins Monday morning, June 11, and ends Friday evening, July 6, 1894.

Field Geology begins Monday morning, July 9, and ends Wednesday evening, August 15, 1894.

Commencement Exercises, Thursday and Friday, August 16 and 17, 1894.

Thursday—Field day, all classes, 9 A.M. and 2 P.M.
Reception for the Graduating Class, by the Board of Control and Faculty, 9 P.M.

Friday—Annual Meeting of the Board of Control, 10 A.M.
Graduation Exercises, 2 P.M.
Meeting of the Alumni Association, 4 P.M.
Alumni Dinner, 8:30 P.M.

Recess of Four Weeks.

FALL TERM commences Friday morning, September 14, 1894.

Examinations for admission and advanced standing commence Friday at 9 A.M., and continue through Friday and Saturday.

Examinations for making up conditions commence on Friday at 9 A.M., and will continue through Friday and Saturday.

Regular work for all classes commences Monday, September 17, 1894, at 9 A.M.

Thanksgiving Recess, November, Wednesday noon until Monday morning.

Fall Term ends Friday evening, December 21, 1894.

Recess of Two Weeks.

WINTER TERM commences Monday morning, January 7, and ends Friday evening, April 12, 1895.

Recess of Nine Days.

SUMMER TERM commences Monday morning, April 22, 1895, and ends Friday evening, August 16, 1895.

Field Work in Surveying commences Monday morning, June 23, and ends Wednesday evening, August 14, 1895.

Shop Practice begins Monday morning, June 10, and ends Wednesday evening, August 14, 1895.

Practical Work in Assaying begins Monday morning, May 27, and ends Friday evening, June 7, 1895.

Practical Work in Ore Dressing commences Monday morning, June 10, and ends Friday evening, July 5, 1895.

Field Geology begins Monday morning, July 8, and ends Wednesday evening, August 14, 1895.

Commencement Exercises, Thursday and Friday, August 15 and 16, 1895.

Thursday Field day, all classes, 9 A.M. and 2 P.M.
Reception for the Graduating Class, by the Board of Control and Faculty, 9 P.M.
Friday – Annual Meeting of the Board of Control, 10 A.M.
Graduation Exercises, 2 P.M.
Meeting of the Alumni Association, 4 P.M.
Alumni Dinner, 8:30 P.M.

Recess of Four Weeks.

FALL TERM commences Friday morning, September 13, 1895.

Examinations for admission and advanced standing commence Friday morning, at 9 A.M., and continue through Friday and Saturday.

Examinations for making up conditions commence on Friday, at 9 A.M., and will be continued through Friday and Saturday.

Regular work for all classes commences Monday, September 16, 1895, at 9 A.M.

Thanksgiving recess, November, Wednesday noon until Monday morning.

Fall Term ends Friday evening, December 20, 1895.

Recess of Two Weeks.

WINTER TERM commences Monday morning, January 6, and ends Friday evening, April 10, 1896.

Recess of Nine Days.

SUMMER TERM commences Monday morning, April 20, 1896, and ends Friday evening, August 14, 1896.

Field Work in Surveying commences Monday morning, June 1, and ends Wednesday evening, August 12, 1896.

Shop Practice begins Monday morning, June 8, and ends Wednesday evening, August 12, 1896.

Practical Work in Assaying begins Monday morning, June 1, and ends Friday evening, June 12, 1896.

Practical work in Ore Dressing commences Monday morning, June 8, and ends Friday evening, July 3, 1896.

Field Geology begins Monday morning, July 6, and ends Wednesday evening, August 12, 1896.

Commencement Exercises, Thursday and Friday, August 13 and 14, 1896.

Thursday—Field Day—All classes, 9 A.M. and 2 P.M.
Reception for the Graduating Class by the Board of Control and the Faculty.
Friday—Annual Meeting of the Board of Control, 10 A.M.
Graduation Exercises, 2 P.M.
Meeting of the Alumni Association, 4 P.M.
Alumni Dinner, 8:30 P.M.

FALL TERM commences Friday morning, September 11, 1896.

Examinations for admission and advanced standing commence Friday morning, at 9 A.M., and continue through Friday and Saturday.

Examinations for making up conditions commence on Friday at 9 A.M., and continue through Friday and Saturday.

Regular work for all classes commences Monday, September 14, 1896, at 9 A.M.

Thanksgiving Recess, November, Wednesday noon until Monday morning.

Fall Term ends Friday evening, December 18, 1896.

Recess of Two Weeks.

WINTER TERM commences Monday morning, January 4, 1897, and ends Friday evening, April 9, 1897.

Recess of Nine Days.

SUMMER TERM commences Monday morning, April 19, and ends Friday evening, August 13, 1897.

Recess of Four Weeks.

FALL TERM commences Friday morning, September 10, 1897, and ends Friday evening, December 17, 1897.

CALENDAR, 1894.

	S	M	T	W	T	F	S		S	M	T	W	T	F	S
JAN		1	2	3	4	5	6	JULY	1	2	3	4	5	6	7
	7	8	9	10	11	12	13		8	9	10	11	12	13	14
	14	15	16	17	18	19	20		15	16	17	18	19	20	21
	21	22	23	24	25	26	27		22	23	24	25	26	27	28
	28	29	30	31					29	30	31				
FEB					1	2	3	AUG				1	2	3	4
	4	5	6	7	8	9	10		5	6	7	8	9	10	11
	11	12	13	14	15	16	17		12	13	14	15	16	17	18
	18	19	20	21	22	23	24		19	20	21	22	23	24	25
	25	26	27	28					26	27	28	29	30	31	
MARCH					1	2	3	SEPT							1
	4	5	6	7	8	9	10		2	3	4	5	6	7	8
	11	12	13	14	15	16	17		9	10	11	12	13	14	15
	18	19	20	21	22	23	24		16	17	18	19	20	21	22
	25	26	27	28	29	30	31		23	24	25	26	27	28	29
									30						
APRIL	1	2	3	4	5	6	7	OCT		1	2	3	4	5	6
	8	9	10	11	12	13	14		7	8	9	10	11	12	13
	15	16	17	18	19	20	21		14	15	16	17	18	19	20
	22	23	24	25	26	27	28		21	22	23	24	25	26	27
	29	30							28	29	30	31			
MAY			1	2	3	4	5	NOV					1	2	3
	6	7	8	9	10	11	12		4	5	6	7	8	9	10
	13	14	15	16	17	18	19		11	12	13	14	15	16	17
	20	21	22	23	24	25	26		18	19	20	21	22	23	24
	27	28	29	30	31				25	26	27	28	29	30	
JUNE						1	2	DEC							1
	3	4	5	6	7	8	9		2	3	4	5	6	7	8
	10	11	12	13	14	15	16		9	10	11	12	13	14	15
	17	18	19	20	21	22	23		16	17	18	19	20	21	22
	24	25	26	27	28	29	30		23	24	25	26	27	28	29
									30	31					

CALENDAR, 1895.

	S	M	T	W	T	F	S		S	M	T	W	T	F	S
Jan.			1	2	3	4	5	**July.**		1	2	3	4	5	6
	6	7	8	9	10	11	12		7	8	9	10	11	12	13
	13	14	15	16	17	18	19		14	15	16	17	18	19	20
	20	21	22	23	24	25	26		21	22	23	24	25	26	27
	27	28	29	30	31				28	29	30	31			
Feb.						1	2	**Aug.**					1	2	3
	3	4	5	6	7	8	9		4	5	6	7	8	9	10
	10	11	12	13	14	15	16		11	12	13	14	15	16	17
	17	18	19	20	21	22	23		18	19	20	21	22	23	24
	24	25	26	27	28				25	26	27	28	29	30	31
March.						1	2	**Sept.**	1	2	3	4	5	6	7
	3	4	5	6	7	8	9		8	9	10	11	12	13	14
	10	11	12	13	14	15	16		15	16	17	18	19	20	21
	17	18	19	20	21	22	23		22	23	24	25	26	27	28
	24	25	26	27	28	29	30		29	30					
	31														
April.		1	2	3	4	5	6	**Oct.**			1	2	3	4	5
	7	8	9	10	11	12	13		6	7	8	9	10	11	12
	14	15	16	17	18	19	20		13	14	15	16	17	18	19
	21	22	23	24	25	26	27		20	21	22	23	24	25	26
	28	29	30						27	28	29	30	31		
May.				1	2	3	4	**Nov.**						1	2
	5	6	7	8	9	10	11		3	4	5	6	7	8	9
	12	13	14	15	16	17	18		10	11	12	13	14	15	16
	19	20	21	22	23	24	25		17	18	19	20	21	22	23
	26	27	28	29	30	31			24	25	26	27	28	29	30
June.							1	**Dec.**	1	2	3	4	5	6	7
	2	3	4	5	6	7	8		8	9	10	11	12	13	14
	9	10	11	12	13	14	15		15	16	17	18	19	20	21
	16	17	18	19	20	21	22		22	23	24	25	26	27	28
	23	24	25	26	27	28	29		29	30	31				
	30														

CALENDAR, 1896.

	S	M	T	W	T	F	S		S	M	T	W	T	F	S
Jan.	.			1	2	3	4	July.	..		.	1	2	3	4
	5	6	7	8	9	10	11		5	6	7	8	9	10	11
	12	13	14	15	16	17	18		12	13	14	15	16	17	18
	19	20	21	22	23	24	25		19	20	21	22	23	24	25
	26	27	28	29	30	31			26	27	28	29	30	31	..
Feb.							1	Aug.							1
	2	3	4	5	6	7	8		2	3	4	5	6	7	8
	9	10	11	12	13	14	15		9	10	11	12	13	14	15
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	23	24	25	26	27	28	29		23	24	25	26	27	28	29
									30	31					
March.	1	2	3	4	5	6	7	Sept.			1	2	3	4	5
	8	9	10	11	12	13	14		6	7	8	9	10	11	12
	15	16	17	18	19	20	21		13	14	15	16	17	18	19
	22	23	24	25	26	27	28		20	21	22	23	24	25	26
	29	30	31						27	28	29	30			
April.				1	2	3	4	Oct.					1	2	3
	5	6	7	8	9	10	11		4	5	6	7	8	9	10
	12	13	14	15	16	17	18		11	12	13	14	15	16	17
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	26	27	28	29	30				25	26	27	28	29	30	31
May						1	2	Nov.	1	2	3	4	5	6	7
	3	4	5	6	7	8	9		8	9	10	11	12	13	14
	10	11	12	13	14	15	16		15	16	17	18	19	20	21
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	24	25	26	27	28	29	30		29	30					
	31														
June		1	2	3	4	5	6	Dec.			1	2	3	4	5
	7	8	9	10	11	12	13		6	7	8	9	10	11	12
	14	15	16	17	18	19	20		13	14	15	16	17	18	19
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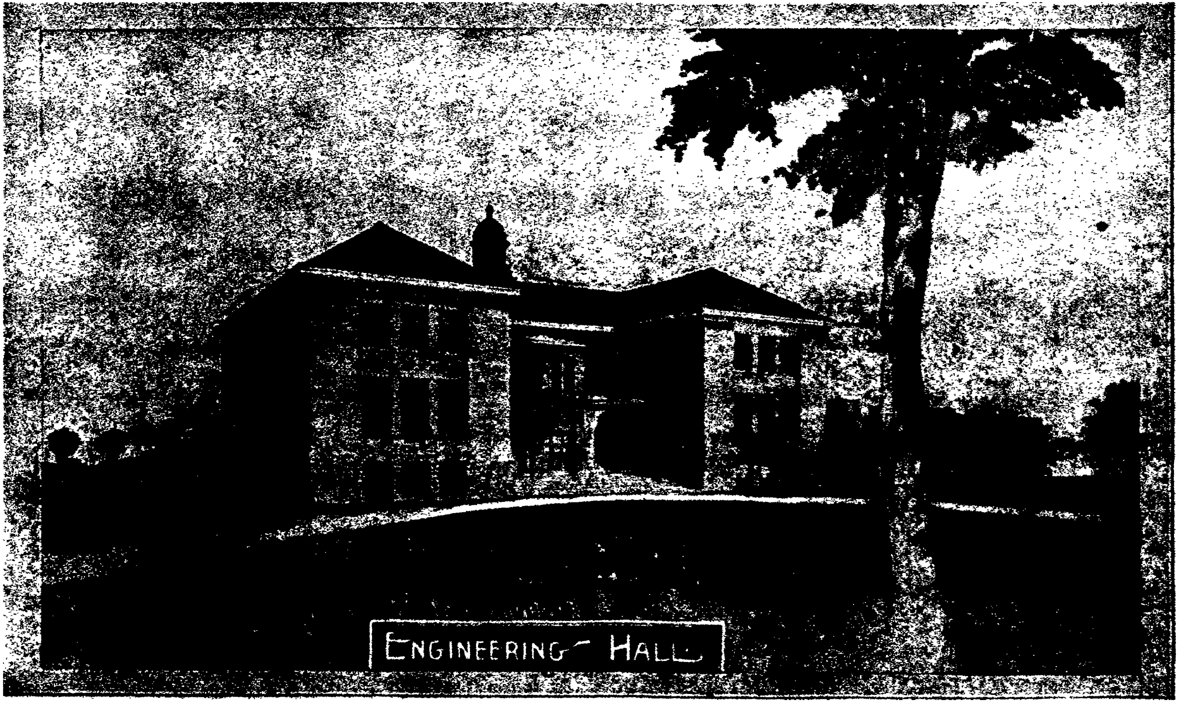

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